STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

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Price $1.00

STATE OF CALIFORNIA
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DEPARTMENT OF NATURAL RESOURCES
DEWITT NELSON, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

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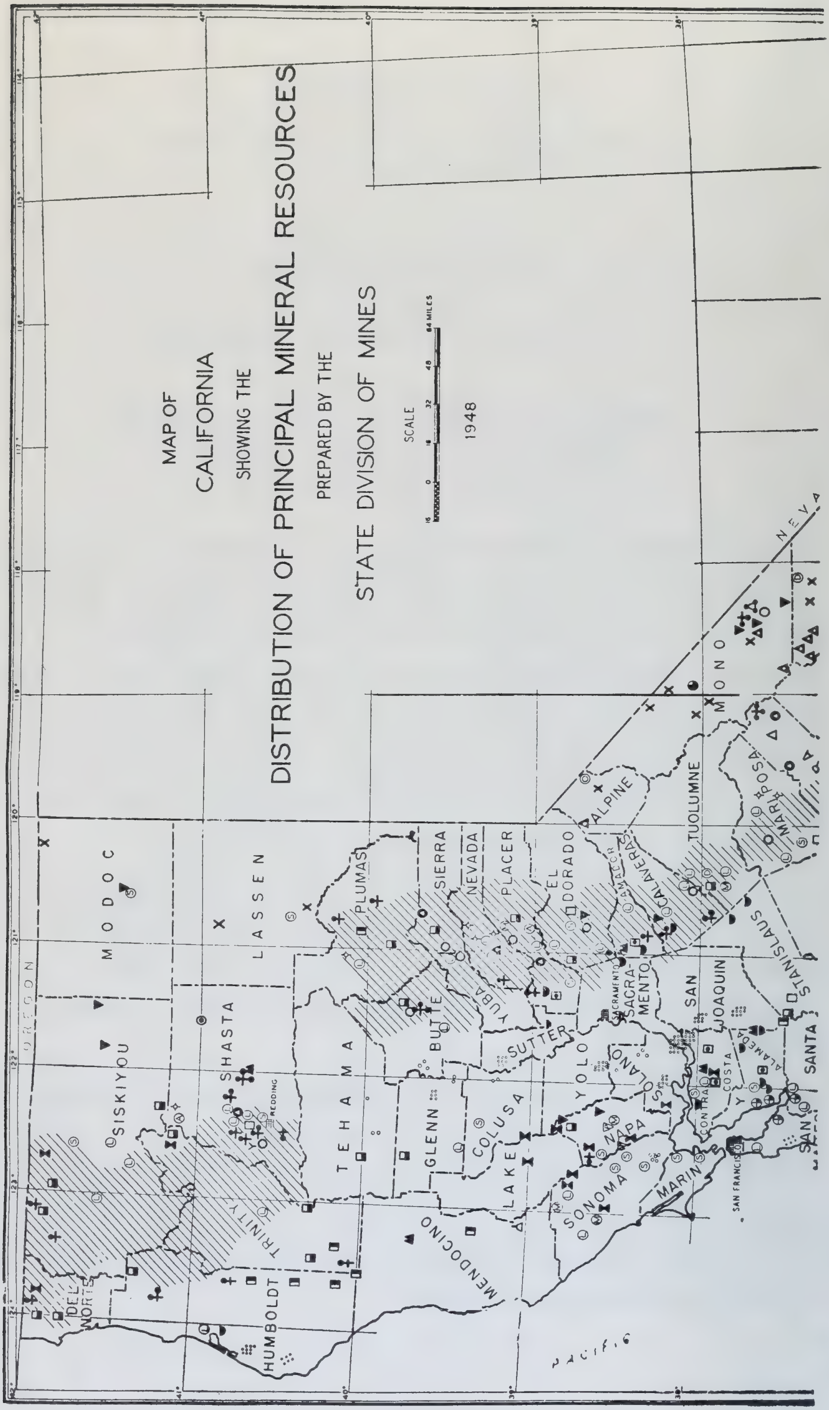
Third Floor, Ferry Building, San Francisco 11

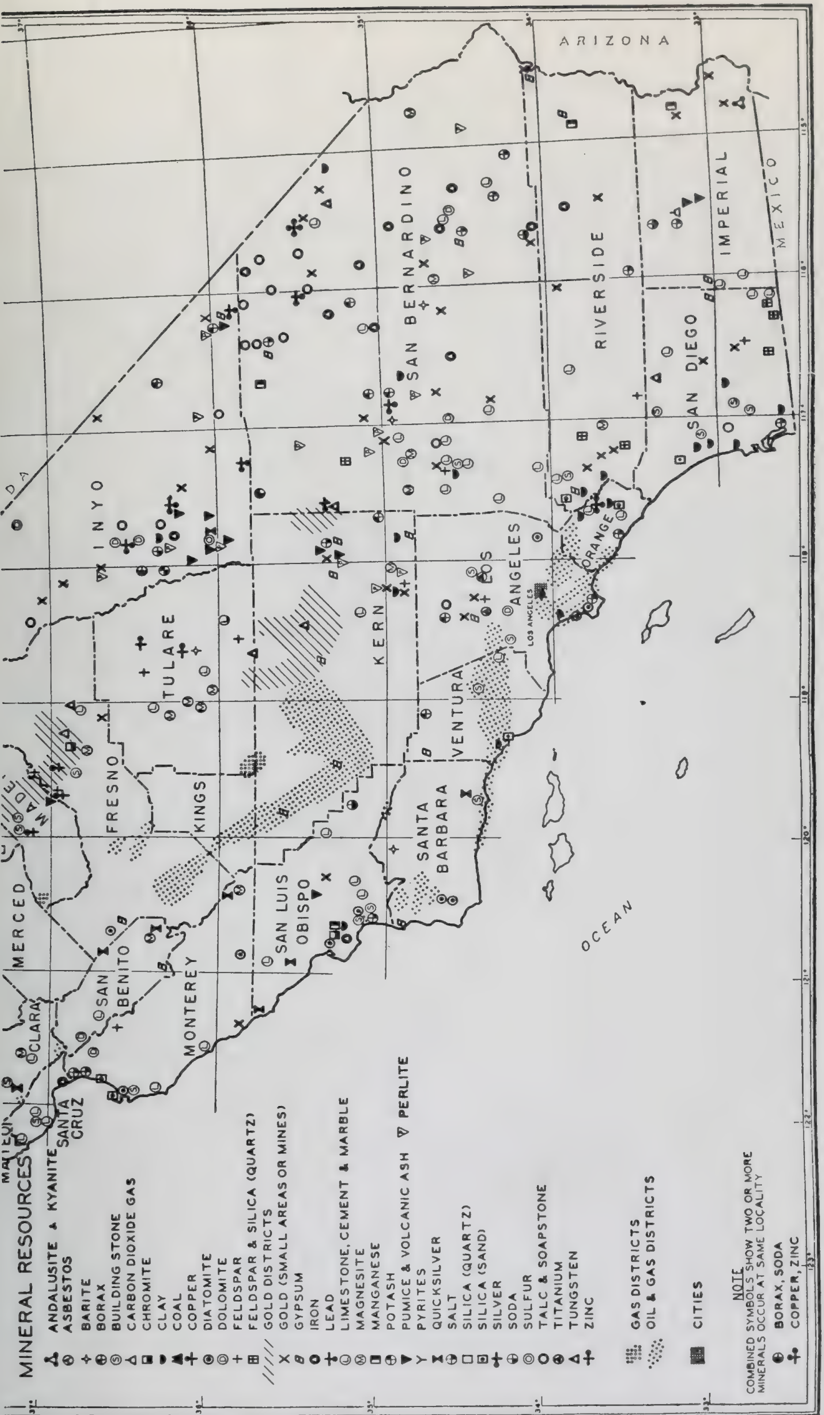
Branch Offices
State Building, 217 West First Street, Los Angeles 12
Third Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles, Sacramento and Redding branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
NEVA
PACIFIC
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
MENDOCINO
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
SONOMA
NAPA
YOLO
ALPINE
SACRAMENTO
SACRA-MENTO
AMADOR
CALAVERAS
SOLANO
MARIN
TUOLUMNE
SAN JOAQUIN
CONTRA COSTA
SAN FRANCISCO
MONO
ALAMEDA
MARIPOSA
STANISLAUS
SAN
SANTA


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY
BORAX, SODA
COPPER, ZINC
SANTA CRUZ
CLARA
SAN BENITO
MERCED
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN

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ANNUAL REPORT OF THE STATE MINERALOGIST CHIEF OF THE DIVISION OF MINES

FOR THE 104TH FISCAL YEAR JULY 1, 1952 TO JUNE 30, 1953

By Olaf P. Jenkins *

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* State Mineralogist and Chief of the Division of Mines, Department of Natural Resources.

2—84395

LETTER OF TRANSMITTAL

De Witt Nelson
Director, Department of Natural Resources
Sacramento, California

Sir: I have the honor to transmit herewith for reference to Governor Goodwin J. Knight the annual report of the State Mineralogist, Chief of the Division of Mines, for the 104th fiscal year, July 1, 1952, to June 30, 1953. This is in accordance with the requirement in amended Section 2203 of the Public Resources Code. The procedure followed in last year's annual report has been repeated herein; namely, sections of the Public Resources Code are quoted to give documentary evidence of what is required of the Division of Mines and to show that the program followed adhered to the Code.

This report, however, has been more specific in its endeavor to explain the broad scope of the Division's work and to outline its current projects assigned to staff members, who now have made considerable progress in their research work. The services, activities, and accomplishments of the Division have increased considerably over last fiscal year, though the support is practically unchanged save for a small increase to meet increased costs.

There is no doubt that the Division has contributed materially to the technical knowledge and encouragement of the state's great mineral industry, which in 1952 produced $1,236,238,000 worth of mineral materials, the largest annual figure to date. Moreover, the Division serves many industries which extend far beyond the mining of raw minerals—all those industries that use minerals in the manufacture of all manner of products required by the state's ever-increasing population. This is a service to a growing multi-billion dollar industry which needs to know where it can obtain local sources of raw mineral materials to use in the making of marketable products. In giving this information, the Division of Mines helps to add vast wealth to the economic structure of the State of California.

Respectfully submitted,

Olaf P. Jenkins
State Mineralogist and
Chief of the Division of Mines

Ferry Building, San Francisco

ABSTRACT

The scope of the Division of Mines activities includes the study of all mineral commodities: mineral fuels, salines, nonmetallics, and metals. In 1952 the annual production reached an all-time high in quantity, and also in value, which was $1,236,238,000. The Division of Mines serves both the producer and user of minerals; its functions include acquiring information through various surveys and giving information through publication of data, oral interviews, and correspondence. These activities and services were all increased during the fiscal year. By the end of the fiscal year the staff of the Division included 31 technical and 24 non-technical employees. The support received was 11 percent more than the previous year and sufficient to cover increased costs.

Most of the work of the Division was done from the headquarters office in San Francisco. Of the three branch offices, in Los Angeles, Sacramento, and Redding, the Los Angeles office performed by far the greatest number of services. The large market area for industrial minerals in southern California and the practically unlimited sources of raw materials in that region indicate that the services required of the Los Angeles office will in the future increase at an even greater rate than they have before.

Five types of surveys are continuously carried on by the Division: basic geologic surveys, mineral commodity surveys, mining activity surveys, mineral economic surveys, and mineral utilization surveys. Progress has been made in each of these lines of endeavor. Cooperation with the federal Geological Survey, the federal Bureau of Mines, the departments of geology in universities, and the research departments of commercial concerns has been outstanding. The publications of the Division of Mines include reports prepared not only by staff members but by members of cooperating agencies and contributors from other professional sources.

The library of the Division has expanded; services of the laboratory for the public and for staff members have increased. The laboratory identified 4138 samples of minerals submitted by the public during the fiscal year, which was an outstanding record—115 percent over 1947 and 17 percent over 1952. A total of 208 sets of minerals were sent to schools. Staff members appeared before 171 public gatherings for the purpose of disseminating information. The monthly issue of *Mineral Information Service* has now reached 22,000. Its reception has been outstanding, as evidenced by hundreds of letters of praise from people who receive this pamphlet. The *California Journal of Mines and Geology* is principally devoted to reports on mineral inventories, mineral utilization, and the annual report of the State Mineralogist. Five new bulletins were issued during the fiscal year, eleven special reports, and four reprints. Many other technical reports are in press and in preparation, including eight of the thirty sheets of the new state geologic map, scale 1:250,000. The sale of the Division's publications amounted to $22,626.84.

Quadrangle geologic maps and other basic geology proved to be of service to a very large audience, but especially to the oil and gas industry. Mineral commodity surveys making special progress were those on chromite, gypsum (published as Bulletin 161), common salt, boron and other saline minerals, strontium, talc, lead and zinc, asbestos, lightweight aggregates, limestone and dolomite, and petroleum. The state's mineral commodities, numbering about 70, were all given considerable attention. Mining activities and mineral inventories were completed in Amador, Mendocino, and Santa Clara Counties; such studies are also under way in several other counties. A reconnaissance survey is being carried on in the Klamath Mountains of northwestern California. An investigation of earthquakes, brought on by the inquiries concerning the Arvin-Tehachapi earthquake of 1952, is being published in the form of a bulletin with multiple authorship from various professional sources. A volume on the geology of southern California, authored by a host of geologists, is in preparation.

A statewide mineral utilization survey is being carried on by the Division through the study of industries and what raw minerals they need to manufacture products demanded by the ever-growing population of the state. Progress has been made especially in the industries of agriculture, beet sugar, bituminous-base roofing, cement, ceramics, chlorine-caustic, dimension stone, fertilizer, glass, glass container, glazed wall tile, paint, paint and varnish, perlite, petroleum, pulp and paper, pumice, and rubber.

In conclusion, it is recommended that the broad program of the Division be continued, as it is making good progress and is of service to all industries producing

and using minerals. The basic surveys of the Division result in accumulating a backlog of information which is of permanent value and use to the largest number of people. The educational programs help to build an interest among the younger generation in the mineral resources of the state and the ways in which those resources may be developed to increase the economic wealth of California.

INTRODUCTION

Public Resources Code:

"2203. The State Mineralogist shall make an annual report to the Director for transmission to the Governor on or before the fifteenth day of September next preceding the regular session of the Legislature."

As we enter a new fiscal year (1953-54) we pause to take stock of the work we accomplished the previous year, to review current projects, and to consider how best to proceed with new assignments. In preparing this annual report for the fiscal year 1952-53, the requirements of the Public Resources Code are shown to be a guide for the Division's work, which is closely integrated with the current needs of the mineral industry.

As a technical and scientific bureau, the Division maintains a well-trained staff of mining geologists; a splendid library on geology, mineralogy, mining, mineral processing, mineral industries, and all other related subjects; a laboratory suited to the determination of minerals and rocks; a large working collection of all kinds of minerals; but at present only a few exhibits to show the usefulness of minerals and how they are extracted from the earth and processed to meet the specifications of industry. To a mining geologist, however, the most important laboratory and source of information lies in the field, and the most effective work that can be done is the study of mineral resources in place, and the examination of mines and industrial mineral plants at the location of their operation.

All these studies are made for the purpose of obtaining basic and authoritative information to provide the inquiring public, the professional engineer who is employed to guide industry along profitable ways, and the industries which mine or use raw mineral materials.

The most effective way to disseminate information is through publication. In preparing material for publication, maps must be drawn and reports must be written with extreme care and accuracy. The data for these are all based on field surveys which generally take years to complete. The data must be assembled, synthesized, integrated, and processed in a manner to make the reports understandable to the reader. Some reports are highly technical and directed toward a technical audience. Other reports are written for the layman.

In addition to publication, the Division must answer orally or through correspondence thousands of inquiries each month. By means of public addresses, the use of lantern slides, and technical motion pictures, a large number of people are given information concerning the geology and mineral resources of California.

The Division of Mines is, therefore, constantly engaged in objective research and in carrying on surveys to gain a better understanding of the geology and mineral resources of California and how its vast wealth can be utilized wisely and profitably to advance the state's growing civilization.

SCOPE OF FUNCTIONS

Public Resources Code:

"2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

Since all mineral substances are included in the studies of the Division of Mines, according to the Public Resources Code, and since California is known to be endowed with more than half of all definite mineral species described, the scope of the Division's work is very broad indeed. Out of 534 different species of minerals known to occur in California, a group of about 70 are considered mineral commodities and given special study because they are of commercial value. There probably is no other area on this earth which has a greater diversity of mineral and rock types than California. Many of the mineral deposits, though not mined today, are very important as possible future producers. It is extremely important to know how and when these potentially valuable deposits may become useful and marketable.

In the basic geologic studies of the Division of Mines, different rock formations and mineral deposits are mapped. It is a significant fact that all geologic periods known are represented by rock units in California. This makes the work interesting to geologists from every part of the country, and opens the way to all manner of mineral investigations. The geologic maps that are prepared under the direction of the Division are invaluable not only to miners but to persons who are investigating the occurrence, source, and accumulation of oil, gas, and water beneath the surface of the earth. The maps are also invaluable to engineering enterprises, road construction, the study of earthquakes, soil distribution and agriculture, and to the understanding of landscape, shore-line features, and the relationship of other natural resources such as forests and the distribution of animal and plant life. Even the early history of the state is very closely related to the geologic environment and the occurrence of valuable minerals and rocks. The basic controls of civilization and the economy of the state lie in the distribution and development of its mineral resources.

The scope of the work of the State Division of Mines parallels that of both the federal Geological Survey and federal Bureau of Mines with whom it cooperates and works in close harmony. Cooperation extends also to the geological departments of the several universities of the state and to similar research departments of other scientific and commercial organizations. Without this mutual understanding and cooperative endeavor, the progress of the Division of Mines would be very limited. As it now operates, the public benefits by the service it renders as a clearing house for all information regarding the minerals and rocks of California from all sources.

The annual value of mineral commodities produced in California exceeds one billion dollars. These mineral materials contribute to the manufacture of all manner of products, and the construction of highways, dams, and all kinds of buildings. Therefore, the added value to minerals after they are processed for utilization is many fold the original value of the raw product.

MINERAL PRODUCTION IN CALIFORNIA FOR THE YEARS 1951 AND 1952

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

"2207. The owner, lessor, lessee, agent, manager, or other person in charge of any mine of whatever kind or character within the State shall forward to the State Mineralogist, upon his request, at his office, not

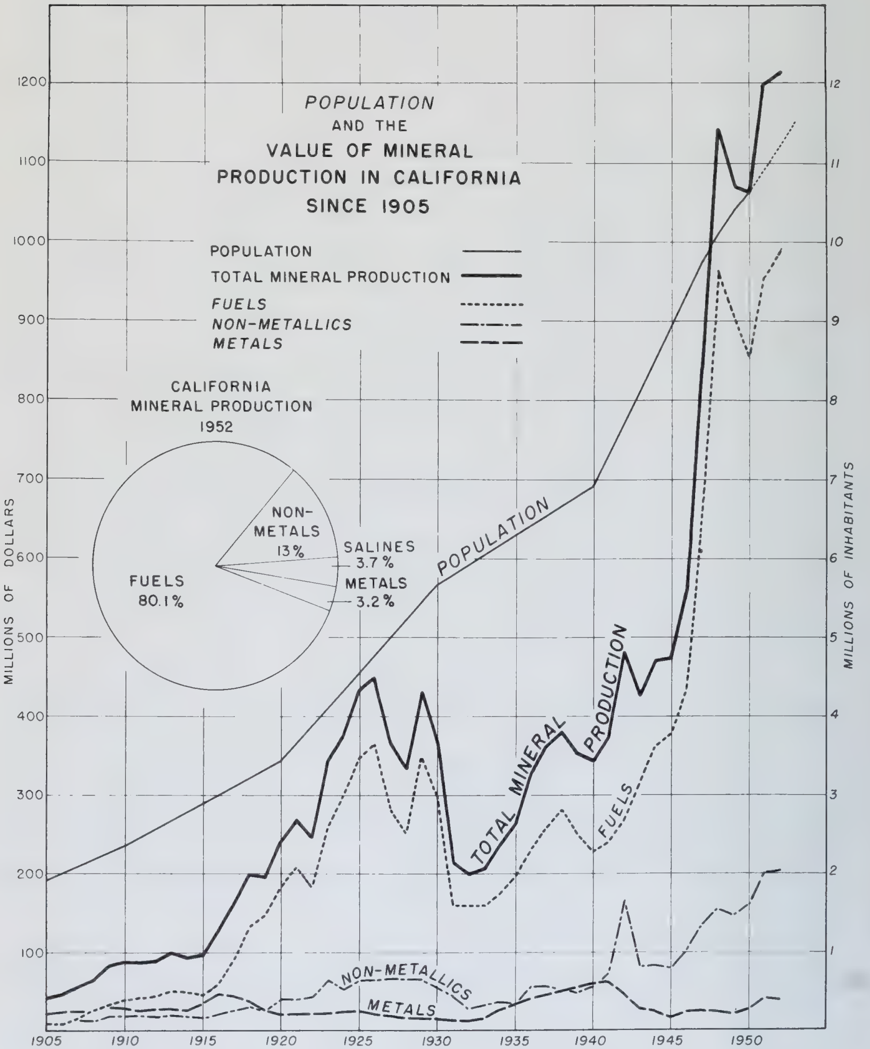

FIGURE 1. Graph showing relative value of mineral production in California.

later than the thirty-first day of March in each year, upon forms which will be furnished, a report showing the character of the mine, the method of working the mine and the general condition thereof, and the total mineral production for the preceding calendar year. Any such person who fails to comply with the provisions of this section is guilty of a misdemeanor.

Such reports shall be confidential. Other records are public records unless excepted by statute. Statistical bulletins based on these reports and published under the provisions of Section 2205 of this code shall be compiled to show, for the State as a whole and separately for each county, the total of each mineral produced therein, provided that, in order not to disclose the production of any operator, no production figure shall be published which represents the production of less than three operators; and when such production figure for any county would conflict with such provision it may be combined with such production figures for one or more other counties. Such bulletins shall be published annually by June 30th or as soon thereafter as practical."

The value of California's 1952 mineral output is estimated at $1,236,238,000, the largest annual value to date. The figures exceed the 1951 figure of $1,201,239,000 by $34,999,000. To date, only a few 1952 final production figures are available.

In 1952 increases in annual production, and an all-time high in quantity and value, were shown by petroleum, natural gas gasoline and liquefied petroleum gases, cement, and miscellaneous stone. Of the metals gold, silver, copper, lead, and zinc registered a decrease in

Summary of mineral production in California for the years 1951 and 1952.

Mineral commodity	Recorded 1951 production		Estimated 1952 production	
	Quantity	Value	Quantity	Value
Gold	339,732 fine oz.	$11,890,620	258,176 fine oz.	$9,036,160
Silver	1,145,219 fine oz.	1,036,481	1,099,658 fine oz.	995,246
Copper	1,842,000 lbs.	445,764	1,600,000 lbs.	387,200
Lead	27,934,000 lbs.	4,832,582	22,398,000 lbs.	3,606,078
Zinc	19,204,000 lbs.	3,495,128	18,838,000 lbs.	3,127,108
Mercury	4,282 flasks	899,777	7,421 flasks	1,477,521
Other metals, including antimony [a], chromite, iron ore, manganese ore [b], molybdenum and tungsten concentrates, and titanium ore	----------	20,234,635	----------	21,100,000
Petroleum	354,275,000 bbls.	795,492,000	359,450,000 bbls.	829,735,000
Natural gas	553,488,157 M cu. ft.	80,917,124	515,528,249 M cu. ft.	76,729,000
Natural gas gasoline	21,131,950 bbls.	65,923,000	21,835,000 bbls.	67,363,000
Liquified petroleum gases	8,400,774 bbls.	15,528,000	8,918,000 bbls.	16,946,000
Cement	28,956,470 bbls.	77,753,697	29,972,000 bbls.	80,936,000
Miscellaneous stone, including granite, limestone, dolomite, sandstone, crushed rock, and sand and gravel	----------	55,062,059	----------	56,200,000
Other nonmetallics, including clay, diatomite, gypsum, lime, pumice, pyrite, talc, etc.	----------	22,290,105	----------	22,950,000
Salines, including borates, bromine, calcium chloride, iodine, magnesium compounds, salt, soda ash, salt cake	----------	45,438,085	----------	45,650,000
Total value	----------	$1,201,239,000	----------	$1,236,238,000

[a] Produced in 1951 only.
[b] Produced in 1952 only.

annual output, while the other metals, such as chromite, iron ore, mercury, manganese ore, and tungsten ore, showed an increased production. Interest in most nonmetallic minerals was strong and increasing.

California mineral production statistics are compiled under a cooperative arrangement between the United States Bureau of Mines and the California Division of Mines. Initial publication of the figures immediately upon their receipt is in *Mineral Information Service*. A final summary, together with the pertinent facts relating to each mineral commodity are published in a subsequent issue of the *California Journal of Mines and Geology*.

ADMINISTRATION

Public Resources Code:

"2201. The State Mineralogist shall employ competent geologists, field assistants, qualified specialists, and office employees when necessary in the execution of the plans and operations of the division under this chapter."

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State."

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State . . ."

Headquarters of the Division of Mines is in the Ferry Building, San Francisco 11, California. Most of the offices and mineral exhibits have been located for many years in the north wing of this building, but now that the Harbor Board has decided to rebuild the north half into a World Trade Center, the Division of Mines is being moved into the south half of the building—offices and library will be on the mezzanine floor, mineral exhibits and laboratories on the second floor, and stock rooms on the ground floor. The office of the State Mineralogist, Chief of the Division of Mines, is located in the Ferry Building. Two Supervising Mining Geologists work as a team to assist in the operations of the Division: business management, together with technical supervision of economic surveys, mine and industrial examinations, are the responsibility of L. A. Norman, Jr.; personnel requirements, together with technical supervision of basic geological and mineralogical surveys, are the responsibility of Gordon B. Oakeshott.

The Division of Mines maintains three branch offices, the largest in Los Angeles, and smaller offices in Sacramento and Redding, which are all effective in extending the services of the Division to the public and in contacting local industry and research workers.

For the most part, the technical personnel of the Division of Mines are classified as *mining geologists*. By July 1, 1953, the staff consisted of 55 employees—31 technical and 24 non-technical.

	1952	1953
San Francisco headquarters office		
Ferry Building, San Francisco 11		
Technical employees	22	22
Non-technical employees	17	20
Los Angeles branch office		
217 West First Street, Room 402B		
Technical employees	6	6
Non-technical employees	2	2
Sacramento branch office		
State Office Building No. 1		
Technical employees	2	2
Non-technical employees	1	1
Redding branch office		
Natural Resources Building		
Technical employees	1	1
Non-technical employees	1	1
Total	52	55

All technical work of the Division is carefully integrated, and once a month the entire technical staff meets in the San Francisco conference room for the purpose of reviewing informally current field activities. The more basic scientific work is considered a necessary background for economic studies. The study of the industrial use of minerals and their extraction from the earth forms part of the work of each mining geologist, who also maps the mineral deposits and geologic formations in the field and identifies in the laboratory the rock and mineral specimens he collects.

Most of the members of the technical staff of the Division are assigned major programs of objective research in addition to their routine duties. The results of the research projects are made available to the public through publications.

In the headquarters office of San Francisco, manuscripts are processed for publication by the editorial section, supervised by Miss Elisabeth L. Egenhoff, who also carries on continuous projects concerning the early history of mineral discovery and development. She is assisted by Miss Mary R. Hill, who serves also as a photographer as well as editor. As a result, a fine collection of excellent illustrative material is being accumulated of both present conditions and historic scenes.

The drafting section of three employees, supervised by Richard A. Crippen, prepares many maps, sections, and charts which form a very significant part of all of the Division's reports.

The mineral laboratories and mineral exhibits used by all members of the staff are cared for by Charles W. Chesterman, who is also engaged in a comprehensive state-wide survey of pumice, perlite, and other lightweight aggregate resources.

The information section interviews the public, answers oral inquiries, and distributes publications over the counter. Generally, more than one staff member is in attendance. It is here, as well as in the laboratory, that junior members gain some of their first experience in the Division. The information section is supervised by Fenelon F. Davis, who also serves as a commodity mining geologist. The information desk is also served by Henry H. Symons who, in addition, is the Division's statistician.

The technical library of the Division of Mines requires the constant care of the librarian, William A. Sansburn. He also visits other libraries in the State to see that the Division's publications are adequately serving the public. His work includes a program of distribution of "school library kits" made up of publications of the Division of special interest to teachers and students. In addition, the library section fulfills requests for the use of technical motion pictures, secured through the federal Bureau of Mines, companies, and other educational sources.

Special and statewide surveys of geology, mineral commodities, mining activities, and mineral utilization are carried on by mining geologists of the Division from the San Francisco office and also from each of the branch offices.

OUTLINE OF THE FUNCTIONAL ORGANIZATION OF THE DIVISION OF MINES

SAN FRANCISCO HEADQUARTERS:

- *Administrative Branch*
  - Personnel control
  - Office management
    - Fiscal control
    - Maintenance and service
    - Stock and mailing
    - Janitor service
  - Public information service
    - Distribution of publications
    - Public interviews
    - Correspondence
    - Public appearances
    - Laboratory service
    - Exhibits
    - Library
  - Publication processing
    - Editorial section
    - Drafting section
  - Cooperative programs
    - University research
    - Federal Geological Survey
    - Federal Bureau of Mines
  - Regional state geologic map compilation
- *Geologic Branch*
  - Basic geologic survey (by quadrangle)
  - Mineral commodities survey (by commodity)
  - Laboratory research
  - Manuscript control
- *Mining Engineering Branch*
  - Mining activities survey (by county)
  - Mineral utilization survey (by industry)
  - Mineral statistics
  - Ore buyers licensing

LOS ANGELES OFFICE:

- Public information
- Surveys of mining activities, mineral commodities, mineral utilization, and basic geology

SACRAMENTO OFFICE:

- Public information
- Mining activities

REDDING OFFICE:

- Public information
- Mining activities

FINANCIAL STATEMENT

Expenditures of the Division of Mines for the fiscal year 1952-53 show an increase of about 11 percent over the fiscal year 1951-52. This increase was caused by increase in prices, services, and wages. However, the work load of the employees increased considerably over the previous fiscal year, as the Division of Mines accomplished more work and performed more services. This was the result of increased demands by the public, together with improved operations of the Division because of better equipment and better trained personnel.

Expenditures of fiscal 1951-52	$390,969
Expenditures of fiscal 1952-53	$434,362

FINANCIAL STATEMENT

Fiscal 1952-53 *

Total salaries and wages		$248,963.80
Operating expenses:		
Freight, cartage and express	$ 814.21	
Telephone and telegraph	2,013.06	
Toll calls	479.06	
Light, heat, and power	1,218.92	
Rent of building space	13,923.00	
Repairs and maintenance	807.24	
Office supplies and services	4,610.21	
Postage	7,619.22	
Photography supplies and services	1,333.23	
Blueprinting	753.40	
Printing bulletins and maps	69,808.84	
Printing, general	1,765.18	
Technical reports	10,093.50	
Auto parts and services, auto gas, oil, tires and tubes	7,060.86	
Travel	13,980.57	
Auto mileage	155.43	
Laboratory supplies and services	4,224.66	
Library supplies and services	828.70	
Exhibits supplies and services	80.47	
Total operating expenses		$141,569.76
Equipment:		
Automobile	$ 3,120.02	
Field	362.01	
Laboratory	944.49	
Library	1,381.72	
Exhibits	515.48	
Office	2,504.28	
Total equipment		$ 8,828.00
Total expenditures		$399,361.56
Special item: Geological exploration in cooperation with U. S. Geological Survey		$ 35,000.00
Grand total		$434,361.56

* Some of the figures given are approximate, because not all bills for the fiscal year were paid at the time this report was prepared.

PUBLIC INFORMATION SERVICE

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State . . ."

Information provided by the Division of Mines concerns all aspects of the mineral resources and mineral industry of California and is made available by many means to a diverse audience. It is difficult to assess by figures the success of the program, since a large and important part of it is accomplished by means of which no easily assembled record is available. These include information provided during the course of field investigations, at public gatherings, at professional meetings, at federal, state, and local government hearings, and through widely circulated Division of Mines publications. However, an indication of the success and continued growth of the program can be ascertained from the following record of personal services; circulation of the pamphlet *Mineral Information Service,* published monthly as a current event calendar and source of data; and other Division of Mines operational data.

Information Services

Personal services (correspondence, telephone, and visitors)	1951-52	1952-53	Percent increase
San Francisco	39,464	43,309	10
Los Angeles	16,239	19,472	20
Sacramento	2,394	2,719	14
Redding	2,003	2,079	4
Totals	60,100	67,579	12
Various services			
Incoming pieces of mail (San Francisco)	42,000	47,568	13
Outgoing pieces of mail (San Francisco)	204,895	234,016	14
Museum education tours			
Groups	78	77	--
Persons	2,552	3,001	18
Mineral Information Service			
Average monthly circulation	13,059	16,290	25

In particular, hundreds of letters commenting favorably on *Mineral Information Service* show that the Division's services are appreciated by a large and widely distributed audience.

Among the various types of information provided by the Division of Mines are:

(1) *Basic Geologic Data.* Examples: Providing geologic data to numerous exploration geologists, especially those connected with oil companies; providing unpublished data on San Fernando area to three oil companies; providing Division of Water Resources with compilation data of state map; assisting Los Angeles Department of Power and Water with basic information on the Verdugo Hills.

(2) *Sources of Mineral Raw Materials.* Example: Providing data on granite quarries and dimension stone markets upon request of a quarry

operator; supplying information on soapstone to a major clay company; assisting a testing laboratory with location of aggregate materials; locating source of high iron-alumina rock for a cement producer; supplying federal Bureau of Mines with information on titanium; giving information to consulting geologists on potential nickel deposits of Del Norte County; assisting a company with information on bentonite deposits and on laterite deposits; supplying a company with information on drilling mud; discussing potential asbestos deposits of California with a geologist representing an eastern producer; providing a list of sand and gravel companies to a land holder who later leased one of his deposits; securing samples and information on mercury ores for research geologists at the University of California at Los Angeles.

(3) *Mineral Utilization and Marketing Data.* Examples are too numerous to mention.

(4) *Physical and Chemical Data on Rocks and Minerals.* Examples: As part of the daily routine, determining minerals and rocks sent in by the public; supplying southern California producer with technical data on several limestone deposits; assisting a lead-silver operator by the identification of ore and gangue mineral on his property; studying thin rock sections to facilitate structural evaluation of a proposed dam site; making specific gravity tests of barite for a claim owner; supplying information on mining and marketing of mica.

(5) *Production and Processing Data.* Examples are very numerous since nearly everyone wishes information on production and how to process minerals.

(6) *Suggested Procedures for Preparing Documents, Applications, and Forms Relating to the Mineral Industry.* Example: By providing a publication known as *Legal Guide for California Prospectors and Miners,* such questions are largely answered. The *Legal Guide* is so popular that it constantly goes through reprinting. In one case, a zinc property owner was assisted in processing a Defense Minerals Procurement Administration loan request.

(7) *Establishing Itineraries and Acting as Guides.* Examples: For local mineral societies; for technical geological excursions; in one case, for a member of the Geological Survey of India, who visited mines and plants in California.

MINERAL LABORATORY

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a laboratory in San Francisco for the purposes provided in this chapter."

The laboratory of the Division of Mines reported on 4,138 samples of minerals submitted by the public during the 1952-53 fiscal year. This is an outstanding record and represents an increase of 115 percent over the 1947-48 fiscal year of 5 years ago, and a 17 percent increase of last fiscal year. The public showed special interest in the strategic ore minerals of chromium, manganese, mercury, tungsten, the rare-earth elements, and radioactive materials. Many samples of nonmetallic

industrial minerals were received, together with many inquiries concerning them, their commercial uses, and the requirements by industry.

The facilities of the research laboratory were in constant use by various staff members of the Division, who required the petrographic equipment of the microscope and the spectograph to assist them in their assignments on the study of mineral commodities. The universal stage of the petrographic microscope in particular proved to be of great assistance in the accurate and rapid determination of the plagioclase feldspars and other important rock-forming minerals. This is a necessary requisite in the determination of the various kinds of rocks which are found in the field during geologic mapping.

The photographic equipment and dark room of the Division were used frequently in the compilation program of the new state geologic map. Many large-scale detailed maps are redrawn and generalized, then reduced photographically to the scale of the regional compilation of 1:250,000, and traced on the new map.

MINERAL EXHIBITS

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum . . . in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . .

(c) Make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes."

"2206. The State Mineralogist may prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the State."

The mineral exhibits of the Division of Mines were visited by many groups of school children and other individuals interested in seeing on display outstanding gem, mineral, ore, and rock specimens. The job of improving the various displays in the museum was continued, new exhibit materials were received and cataloged, and new mineral exhibit cases were designed to be used after the Division is moved from the north to the south wing of the Ferry Building.

A total of 208 sets of minerals and rocks were provided the elementary schools throughout California. Each set contains from 40 to 60 different kinds of minerals and rocks and forms a very instructive collection. This number of sets is the largest ever distributed in one year and represents an increase of 16 percent over the previous year. At the end of the year there remained 14 unfilled requests for these educational sets of minerals. To collect the material, to prepare and label it properly, and to distribute it as requested is indeed quite a task, but the satisfaction gained by the schools as testified by the school children themselves, shows that the project is well worth while.

MINERAL ACCESSIONS

Public Resources Code:

"2204. The State Mineralogist may receive on behalf of this State, for the use and benefit of the division, gifts, bequests, devices, and legacies of real or other property and may use the same in accordance with the wishes of the donors. If no instructions are given by the

donors, the State Mineralogist shall manage, use, and dispose of the gifts, bequests, and legacies for the best interest of the division and in such manner as he may deem proper."

The following specimens were donated to the museum of the Division of Mines during the 1952-53 fiscal year.

21508 Vanadinite ($Pb_5(VO_4)_3Cl$), lead chloride-vanadate with descloizite ($(Zn,Cu)Pb(VO_4)(OH)$) and mottramite ($(Cu,Zn)Pb(VO_4)(OH)$) on dolomite ($Ca,Mg(CO_3)_2$). From Apache mine, near Globe, Arizona. Donor: B. W. Troxel, 1952.

21509 Calcite ($CaCO_3$), calcium carbonate, variety called iceland spar. From Pike County, Illinois. Donor: Kenneth Greer, 1952.

21510 Scheelite ($CaWO_4$), calcium tungstate in quartz (SiO_2). From Panamint tungsten mine, Inyo County, California. Donor: Thad G. Green, 1952.

21511 Scheelite ($CaWO_4$), calcium tungstate. Part of a large crystal from M.G.L. mine, Pershing County, Nevada. Donor: H. J. Beachlin, 1952.

21512 Monazite ($(Ce,La)(PO_4)$), a phosphate of the cerium metals. Concentrate from Warren Creek, Warren, Idaho. Donor: F. C. Van Deinse, 1952.

21513 Epidote ($HCa_2(Al,Fe)_3Si_3O_{13}$), calcium, aluminum, iron silicate on quartz (SiO_2). From Montezuma claim, Tuolumne tungsten mine, Tuolumne County, California. Donor: Robert Loasching, 1952.

21514 Corundum (Al_2O_3), aluminum oxide in quartz-biotite schist. From Mount San Jacinto, Riverside County, California. Donor: Paul Walker, 1952.

21515 Chromium (Cr), chromium metal. Electrolytic chromium from Boulder City, Nevada. Donor: U. S. Bureau of Mines, 1952.

21516 Troegerite ($(UO_2)_3(AsO_4)_2 \cdot 12H_2O$), hydrous uranium arsenate in sandstone. From Riverton, Utah. Donor: Tony Kirtley, 1953.

21517 Quartz var. Amethyst (SiO_2), silicon dioxide with prehnite ($H_2Ca_2Al_2(SiO_4)_3$) and laumontite ($(Ca,Na_2)Al_2Si_4O_{12} \cdot 4H_2O$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

21518 Stilbite ($(Na_2,Ca)Al_2Si_6O_{16} \cdot 6H_2O$), hydrous sodium, calcium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

21519 Stilbite ($(Na_2,Ca)Al_2Si_6O_{16} \cdot 6H_2O$), hydrous sodium, calcium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

21520 Pyrite (FeS_2), iron sulfide in calcite ($CaCO_3$). From Agstone quarry, Danbury, Connecticut. Donor: T. Orchard Lisle, 1952.

21521 Purpurite ($(Mn,Fe)(PO_4)$), manganese, iron phosphate. From Palmero mine, West Rumney, New Hampshire. Donor: T. Orchard Lisle, 1952.

21522 Heulandite ($(Ca,Na_2)Al_2Si_6O_{16} \cdot 5H_2O$), hydrous calcium, sodium, aluminum silicate with laumontite ($(Ca,Na_2)Al_2Si_4O_{12} \cdot 4H_2O$) on prehnite ($H_2Ca_2Al_2(SiO_4)_3$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

21523 Heulandite ($(Ca,Na_2)Al_2Si_6O_{16} \cdot 5H_2O$), hydrous calcium, sodium, aluminum silicate on quartz (SiO_2). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

21524 Quartz var. smoky (SiO_2), silicon dioxide with rosettes of hematite (Fe_2O_3) on chalcedony (SiO_2). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1952.

LIBRARY

Public Resources Code:

"2205. The State Mineralogist shall: . . .

(d) Provide a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the library of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes.

(f) Preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours.

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State to consist of such collections and library, and arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it."

The following summary report, provided by the Librarian, shows increased activities and services.

Service	*1951-52*	*1952-53*
Books and maps used by visitors	3,068	4,094
Books and maps used by staff members	2,658	4,394
Exchange mailing list—added	10	18
Library mailing list—added	19	153
Publications issued by stock order	800	2,443
Teachers' kits distributed	76	167
Film loans	17	19
Film showings by librarian	---	4
Interlibrary loans: Outgoing	17	26
Incoming	4	33

Receipts

Classed books:	*1951-52*	*1952-53*
Purchase	212	213
Exchange	21	67
Donation	52	64
Duplicate exchange	--	42

	1951-52	1952-53
Total classed books received	285	386
Number of classed books June 30, 1952 and 1953	8,845	9,231
Serial publications received on exchange	---	1,022
Periodicals:		
Subscriptions for San Francisco library	47	56
Subscriptions for branch offices	11	14
Exchange	102	140
Newspapers	---	30
Maps	244	747

Exchange Program. The results of current research in geology and the mineral sciences continue to reach the library in a flow of published materials from the various states and from countries in each of the continents. During the year materials were received in increasing numbers from Japan and the Philippines and Formosa. In Europe exchange relations have been established with the Institute for Geological and Subsurface Research, Athens; the Geographical Institute, University of Bonn; the Academy of Sciences of Finland, Helsinki; the Geophysical Laboratory at the University of Lausanne; and in Israel with the Geological Institute. In this country additions to our exchange mailing list include state universities in Tennessee, Utah, Idaho, and Florida, as well as publishing houses, museums, and other scientific institutions.

Public Relations. The librarian visited high school, college, county, and teachers professional libraries, as well as public libraries in 15 California counties. The major purpose has been to focus attention on Division of Mines publications for their educational value in the study of California resources. About 145 libraries in the counties covered have been added to the mailing list of the Division's publications.

	1951-52	*1952-53*
Libraries visited	23	144

BOOKS ADDED TO LIBRARY DURING FISCAL YEAR 1952-53

Allegheny Ludlum Steel Corporation. Stainless steel handbook. Pittsburgh, 1951.

American Bureau of Metal Statistics. Yearbook, 1952. New York.

American Chemical Society, Division of Petroleum Chemistry. General Papers. No. 29. Los Angeles, 1953.

American Cyanamid Company. Flotation reagents. New York, 1947.

American Institute of Mining and Metallurgical Engineers. Problems of clay and laterite genesis symposium. New York, 1952.

American junior colleges. 3rd ed. Washington, American Council on Education, 1952.

American Petroleum Institute. Bibliography on secondary recovery of oil. New York, 1948-49.

American Petroleum Institute. Report of progress—Fundamental research on occurrences and recovery of petroleum, 1948-49, 1950-51. New York, 1950, 1952.

American Petroleum Institute. Petroleum facts and figures. 9th ed., 1950. New York, 1951.

American Society for Testing Materials. A.S.T.M. standards on mineral aggregates, concrete, and nonbituminous highway materials; specifications, methods of testing, definitions. Philadelphia, 1952.

American Society for Testing Materials. Fifty-year index to A.S.T.M. technical papers and reports, 1898-1950. Philadelphia, 1952.

American Society of Photogrammetry. Manual of photogrammetry. 2d ed. Washington, D.C., 1952.

American universities and colleges. 6th ed. Washington, American Council on Education, 1952.

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California. Government code; state government. Sacramento, Printing Division, Documents Section.

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California. State Water Resources Board. Water resources of California. Sacramento, 1951.

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1. Iron mining and geology of the Vermillion Range, Minnesota.
2. Design vs. performance at Concord coal preparation plant.
122. Changes in the processes and products of tin plate industry.
123. The conservation of critical alloys in the constructional alloy steels.
125. To explore new ways.
130. Recent experiments in the recovery of manganese.
133. Correlation of machinability with inclusion characteristics in resulphurized Bessemer steels.
134. Creep and rupture of chromium-nickel austenitic stainless steels.
135. Hardness of various steels at elevated temperatures.
136. Prestressed concrete.
137. The attainment of maximum open hearth production.
139. Selection, care and maintenance of wire rope in mining.
140. Trends in structural engineering.
141. Use of oxygen in the Bessemer converter.
142. Why we now make better stainless steel.
143. Creep and relaxation of high strength steel wires at room temperature.
144. Design conditions for snow melting.
145. The "electronic controller" weds operating and accounting.
146. Historical aspects of and conservation in constructional alloy steels.
148. Brittle strength and transition temperature of structural steel.
150. Methods of training for mobile operations.
153. Photography in steel research.
154. Roof bolting in the Red Ore Mines of the Birmingham District.
156. Danger zones in a blast furnace lining.
157. Functioning of a lubrication organization in heavy rolling mills.
158. Oil well cements.
159. Seventy-one years of blast furnacing at South Works.
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PUBLIC APPEARANCES

Frequently a member of the Division of Mines is requested to appear before some public gathering to give an address on geology or the mineral resources of California. During the fiscal year 1952-53 members of the staff appeared before 171 such gatherings. For example, 18 talks were given on earthquakes. In some instances, on request, the Division's publications are exhibited and sometimes sold. During the year, $1700 worth of publications were sold during such meetings. The following is a list of the types of public gatherings which were attended by staff members of the Division of Mines during fiscal year 1952-53.

Mining and geology (technical and advisory groups)

American Association of Petroleum Geologists (sold publications)
American Ceramic Society (participated in panel discussion and program committee)
American Institute of Mining and Metallurgical Engineers (presented papers, conducted field trips, sold publications, panel discussion)
Association of American State Geologists (host to annual meeting, conducted field trips)
California Hydraulic Mining Association (6 programs presented)
Geological Society of America (papers presented, sold publications)
Los Angeles Chamber of Commerce Mining Committee
Mining Association of the Southwest
San Francisco Chamber of Commerce Mining Committee
Western Mining Council (information provided at meetings)
Society of Economic Geologists
Plumas County Chamber of Commerce and Mining Chapter joint meeting.

Fairs and mineral shows

San Diego County Fair
California State Fair (model mine exhibit)
San Bernardino County Fair
Los Angeles County Fair
Santa Cruz Mineral Show
Sacramento Mineral Society Show
Santa Rosa Gem and Mineral Show
San Luis Obispo Gem and Mineral Society Show
Monterey Bay Mineral Society Show
Castro Valley Mineral Show

Representatives were in continuous attendance throughout the above fairs and shows, exhibiting mineral specimens, selling publications, and giving information on minerals and mining.

Mineral and geological societies

Northern California Geological Society (weekly luncheon meetings)
San Mateo Gem and Mineral Society (talks given)
San Fernando Gem and Mineral Society (talk given)
Glendale Gem and Lapidary Society (talk given)
Los Angeles Mineralogical Society (talk given)
Hollywood Lapidary Society (talk given)
San Joaquin Geological Society (talk given)
Northern California Gem and Mineral Society (talk given)
Geological Society of Sacramento (conducted field trip)
Castro Valley Mineral and Gem Club (talk given, conducted field trip)
Palo Alto Geological Society (talks given, field trips conducted)
Dana Mineral Club (talk given)
Le Conte Geological Club (talk given)
Kern County Mineral and Historical Society
Santa Cruz Mineral Society
Redwood Mineral Society
Santa Rosa Mineral Society (talk given)
San Joaquin Geology Society
Fresno Gem & Mineral Society (talk given, publications display)
Ukiah Stone and Gem Club (talk given)

Educational

Fresno State College natural resources conservation group (conducted field trip)
Golden Gate Academy (talk given)
Laurel Agricultural Center in-service training class (talk given)
Shasta College (talk given)
San Francisco State College teachers group (talk given)
Hillside School, Berkeley (talk given, film shown)
Occidental College Geology Club (talk given)
West Coast Nature School (conducted field trip)
Placer Evening College (conducted field trip)
Montana School of Mines student group (conducted field trip)
Carmel Adult Evening School (talk given)
Notre Dame College (talk given)
Fresno State College geology club (talk given)

Private industry, civic groups, fraternal organizations

Glendale Table of Loyal Knights of the Round Table (talk given)
Jackson Rotary Club (talk given)
Standard Oil Rockhounds (talk given)
San Ramon Valley Improvement Association (talk given)
Southern California Retail Stone Dealers Association (provided data at meeting)
Anderson Kiwanis Club (talk given)
Desk and Derrick Club (conducted field trip)
Wisemens Club, Berkeley-Walnut Creek chapter (talk given)
Standard Oil employees group (talk given)
Naval Research Reserve Company (talk given)
Cal-Ore Chrome Producers meeting

Miscellaneous

Clay and clay technology—Participated in First National Conference and attended University of California clay committee meetings.
Patricks Point State Park (talk given)
California Academy of Sciences (conducted field trip)
Structural Engineers Association (participated in panel discussion)
Montclair church groups (talks given, conducted field trip)
East Bay Engineers Club (talk given)
Journal Club of Stanford University
Walnut Creek Methodist Church group (talk given)
American Congress on Surveying and Mapping
Sierra Club of San Francisco (talks given)
American Geophysical Union, southwest section

Boy Scouts and Scout leaders (conducted field trip)
Boy Paleontologists (attended museum organization meeting; three interviews on KPFA radio science program)
Public Lands Committee, Senate hearing
House Select Small Business Committee on Problems of the Mining Industry (attended hearing, abstracted papers presented, summarized report of solutions).

PUBLICATIONS

Public Resources Code:

"2205. The State Mineralogist shall: . . . (h) Issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this State."

"2209. The State Mineralogist may fix a price upon and dispose of to the public all publications of the division, including reports, bulletins, maps, registers, or other publications. The price shall approximate the cost of publication and distribution. He may also furnish the publications of the division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies.

"2210. All money received by the division from sales of publications issued by the division shall be deposited at least once each month in the State Treasury to the credit of the General Fund . . ."

Four types of publications are issued by the Division of Mines. All except *Mineral Information Service* (sent gratis) are sold to the public at cost of printing. During fiscal 1952-53, $22,626.84 was received from sales of publications. In the previous fiscal year, the total sales were $28,963.55. This unusually high level of sales was due to the publication of a very popular issue, Bulletin 154, *Geologic guidebook of the San Francisco Bay Counties.*

(1) *Mineral Information Service.* Monthly (8½″ x 11″) offset press pamphlet, distributed without cost upon request. This has been issued since February, 1948.

Through this medium, current information and news of mineral developments are given, statistics and market figures are recorded without delay, announcement of new publications permits wider distribution of results of surveys, and a regular mineral commodity study of great interest to the public is reported. New industries have actually been initiated by this service. By the end of fiscal 1952-53, 22,000 copies were being printed each month, of which nearly 16,000 were sent to the regular mailing list and the remaining 6,000 were distributed from the information counters, at meetings, in answer to many written and oral questions, etc.

(2) *California Journal of Mines and Geology.* This is a continuation of the earlier *Report of the State Mineralogist* started in 1880. Quarterly periodical (paper covered, 6″ x 9″) sold separately ($1.00) or by annual subscription ($3.00). Through the medium of the Journal, an inventory of the mines of the state is recorded. County reports on the mines and mineral resources, reports on mineral utilization surveys, final statistical figures, and the annual report of the State Mineralogist are published in the Journal. Each county report is accompanied by a tabulated list of mining properties which is coordinated with a mineral map. In this manner the Division maintains a directory of all mines and significant properties of California.

(3) *Bulletins.* Published at irregular intervals (generally cloth covered, standard format 6″ x 9″, but other sizes also used); cover statewide surveys, broad-subject monographs, and quadrangle geologic surveys; sold at cost of printing. The bulletin most recently issued was No. 158.

(4) *Special Reports.* A new series (paper covered, 8½″ x 11″), started in December, 1950, covering subjects of special concern, but not of state-wide scope or of as broad scope as the Bulletin. The last Special Report issued (to Sept. 1, 1953) is No. 34.

Through the medium of the Special Report the results of units of research are available without much delay. The 8½″ x 11″ page provides more room for tables, photographs, and maps than the standard Journal and Bulletin 6″ x 9″ page. The Special Report is becoming increasingly popular, and has relieved the overloading of the Journal with highly technical reports.

The following list gives the titles of all publications of the Division of Mines for fiscal 1952-53; it is divided into two parts as follows:

(1) Publications issued during fiscal 1952-53 (actually distributed to the public).

(2) Publications in press at close of fiscal 1952-53 (not ready for distribution on June 30, 1952, but in process of publication).

PUBLICATIONS ISSUED DURING FISCAL YEAR 1952-53

As the authorship of reports is not limited to the staff of the Division of Mines, the affiliation of each author is shown by the following symbols:

SDM Member of State Division of Mines
GS Member of U. S. Geological Survey
U Member of a university faculty or student body
C Consultant or member of commercial firm

Mineral Information Service

Vol. 5, No. 7: Adsorbent clay (SDM); California mineral production, 1950 (SDM); Mountain Pass rare-earth operations (SDM); Production and utilization of petroleum in California during 1951 (SDM); National clay conference (SDM); Clay in California (SDM); Clay research as an aid to industry, by Joseph A. Pask (U).

No. 8: Boron compounds (SDM); Mine production of gold, silver, copper, lead and zinc in California in 1950 and 1951 (SDM); Ceramic education in California, by Joseph A. Pask (U).

No. 9: Arvin-Tehachapi earthquake (SDM); The Arvin earthquake of July 21, 1952, by Hugo Benioff, John P. Buwalda, Beno Gutenberg, and Charles F. Richter (U).

No. 10: Minerals in the glass industry (SDM); Price list of available publications of the California State Division of Mines (SDM).

Vol. 6, No. 1: Anhydrite (SDM); Division of Mines museum (SDM); Employment in the mineral extraction industry (SDM); Index to Mineral Information Service, volume 5 (SDM).

No. 2: Topographic maps (SDM); Supplement, Geologic log for Ventura Basin field trip (SDM).

No. 3: Geochemical prospecting (SDM).

No. 4: Serpentine in California (SDM); Trend of the mineral industry of California, by Olaf P. Jenkins (SDM); Glaucophane schist in California (SDM).

No. 5: Gold in California (SDM); School visitors to the Division of Mines (SDM).

No. 6: Location and assessment work (SDM); The production of glazed wall tile in southern California (SDM).

California Journal of Mines and Geology

Vol. 48, No. 3: July, 1952: Mineral needs and problems of the bituminous base roofing industry, by Dozier Finley (C); Mines and mineral resources of Fresno County, California, by C. A. Logan, Lewis T. Braun, and James W. Vernon (SDM).

No. 4: October, 1952: Mines and mineral resources of Contra Costa County, by Fenelon F. Davis and James W. Vernon (SDM); Fluorspar in California, by James W. Crosby III and Samuel R. Hoffman (SDM); Index to volume 47.

Vol. 49, Nos. 1 and 2: January-April, 1953: Annual report of the State Mineralogist, Chief of the Division of Mines for the 103rd fiscal year, July 1, 1951, to June 30, 1952, by Olaf P. Jenkins (SDM); Mines and mineral deposits of San Bernardino County, California, by Lauren A. Wright, Richard M. Stewart, Thomas E. Gay, Jr., and George C. Hazenbush (SDM).

Bulletins

136. Minerals of California, 1952, Supplement, by Joseph Murdoch and Robert W. Webb (U)
158. Evolution of the California landscape, by Norman E. A. Hinds (U)
160. Geology of the Saltdale quadrangle, California, by T. W. Dibblee Jr. (C) and T. M. Gay Jr. (SDM)
162. Geology of the Sebastopol quadrangle, California, by Russel B. Travis (U)
163. Gypsum in California, by William E. Ver Planck (SDM)

Special Reports

20. Geology of the Superior talc area, Death Valley, California, by Lauren A. Wright (SDM)
21. Geology of Burruel Ridge, northwestern Santa Ana Mountains, California, by James F. Richmond (U)
22. Geology of Las Trampas Ridge, Berkeley Hills, California, by Cornelius K. Ham (U)
23. Exploratory wells drilled outside of oil and gas fields in California to December 31, 1950, by Gordon B. Oakeshott, Lewis T. Braun, Charles W. Jennings, and Ruth Wells (SDM)
24. Geology of the Lebec quadrangle, California, by John C. Crowell (U)
25. Rocks and structure of the Quartz Spring area, northern Panamint Range, California, by James F. McAllister (GS-U)
26. Geology of the southern Ridge Basin, Los Angeles County, California, by Peter Dehlinger (U)
27. Alkali-aggregate reaction in California concrete aggregates, by Richard Merriam (U)
28. Geology of the Mammoth mine, Shasta County, California, by A. R. Kinkel Jr. and Wayne E. Hall (GS)
29. Geology and ore deposits of the Afterthought mine, Shasta County, by John P. Albers (GS)
30. Geology of the southern part of the Quail quadrangle, California, by Charles W. Jennings (U-SDM)

Reprints

Publications of the California State Division of Mines to October 1, 1952 (SDM)

California Journal of Mines and Geology, vol. 47, no. 1, January 1951: Limestone in the California beet sugar industry, by F. H. Ballou Jr. (C); Mines and mineral resources of Inyo County, by L. A. Norman Jr. and Richard M. Stewart (SDM)

Geomorphic map of California, prepared by Olaf P. Jenkins (SDM)

Shaded relief map of California, Hal Shelton, chief artist (C)

Miscellaneous Publications

Legal guide for California prospectors and miners, compiled under the direction of L. A. Norman Jr. (SDM)

PUBLICATIONS IN PRESS AT CLOSE OF FISCAL YEAR 1952-53

Mineral Information Service

Vol. 6, No. 7: Volcanic rocks (SDM); Price list of the available publications of the California State Division of Mines (SDM)

California Journal of Mines and Geology

Vol. 49, No. 3: July 1953: Flotative properties of titanium minerals in oleate solutions, by V. S. Pradhan and D. W. Mitchell (U); Mines and mineral resources of Kings County, California, by Charles W. Jennings (SDM); Adsorbent clays in California, by Richard S. Lamar (C)

No. 4: October 1953: Mines and mineral resources of Mendocino County, California, by J. C. O'Brien (SDM); De Argento Vivo, by Elisabeth L. Egenhoff (SDM)

Bulletins

134. Part II, Chapter 2, Chromite deposits of the southern Coast Ranges of California, by George W. Walker and Allan B. Griggs (GS)
Part III, Chapter 5, Chromite deposits in the northern Sierra Nevada, California, by Garn A. Rynearson (GS)
164. Geology of Eel River Valley area, Humboldt County, California, by Burdette A. Ogle (U-C)
166. Geology of Lower Lake quadrangle, California, by James C. Brice (U)
167. Geology of Ortigalita Peak quadrangle, California, by Louis I. Briggs Jr. (U)
168. Geology of Breckenridge Mountain quadrangle, California, by T. W. Dibblee Jr. (C)

Special Reports

31. Geology of the Johnston Grade area, San Bernardino Mountains, California, by Robert B. Guillou (U)
32. Geological investigations of strontium deposits in southern California, by Cordell Durrell (U-GS)
33. Geology of the Griffith Park area, Los Angeles County, California, by George J. Neuerburg (U)
34. Geology of the Santa Rosa lead mine, Inyo County, California, by Edward M. MacKevett (GS)
35. Tungsten deposits of Madera, Fresno, and Tulare Counties, by Konrad B. Krauskopf (GS)
36. Geology of the Palen Mountains gypsum deposit, Riverside County, California, by Richard A. Hoppin (U)
37. Rosamond uranium prospect, Kern County, California, by George W. Walker (GS)

Reprints

The elephant as they saw it, by Elisabeth L. Egenhoff (SDM)

Legal guide for California prospectors and miners, compiled under the direction of L. A. Norman Jr. (SDM)

Bulletin 141, Geologic guidebook along Highway 49—Sierran gold belt: Sierran roads of today and yesterday, by Dorothy G. Jenkins (Contribution); The discovery of gold in California, by Donald C. Cutter (U); History of placer mining for gold in California, by Charles V. Averill (SDM); Sierra Nevada province, by Olaf P. Jenkins (SDM); Geologic history of the Sierran gold belt, by Olaf P. Jenkins (SDM); History of mining and milling methods in California, by C. A. Logan (SDM); Geologic maps and notes along Highway 49, by Oliver E. Bowen Jr. and Richard A. Crippen Jr. (SDM); The formation of quartz veins, by John A. Burgess (C); Mining on Carson Hill, by John A. Burgess (C); Survey of building structures of the Sierran gold belt, 1848-70, by Robert F. Heizer and Franklin Fenenga (U).

POPULAR REPORTS

The Editorial Section of the Division has under way a long-range project on the history of mineral discovery and development in California, and hopes eventually to release a publication on each mineral commodity of particular interest historically. Two have already been

published—*The Elephant as They Saw It,* a series of quotations and pictures that traces the history of gold and gold mining from the time, almost four and a half centuries ago, when the legend of the island of California was first conceived, to the year 1860; and *Fabricas,* a chronicle of the use of mineral materials in building of missions and pioneer settlements in California prior to 1850, presented through the words and drawings of contemporary writers and artists. The third, *De Argento Vivo,* is now in press; it is a chronicle of quicksilver and its mining in California prior to 1860, told through the medium of extracts from writings on quicksilver that date from 300 B.C. to the three-quarter point of the 16th century, and through pictures and extracts from writings on the discovery and mining of quicksilver in California dating from the last quarter of the 18th century to the middle of the 19th century.

The geologic guidebook series of the Division still continues to be in demand: Bulletin 141, *The Mother Lode Country;* Bulletin 154, *The San Francisco Bay Counties Guidebook;* Special Report 11, *Pfeiffer Big Sur State Park*; and a recent volume, Bulletin 158, *Evolution of the California Landscape.* Another bulletin is now in preparation by multiple authorship on the geology of southern California which may prove very popular, though it is more technical than the guidebooks.

One of the most popular recent reports of the Division is the *Legal Guide for California Prospectors and Miners.*

Another bulletin which has been very popular among oil geologists is Bulletin 118, *Geologic Formations and Economic Development of the Oil and Gas Fields of California.* The second printing of it is now nearing exhaustion even though it is out of date. Sections of this book are undergoing revision, but there is no plan to revise and issue an entirely new edition.

STATE GEOLOGIC MAP

The 1938 state geologic map, scale 1:500,000 has been out of stock for over 2 years. Currently, a new state geologic map, scale 1:250,000, is being compiled. The new map, for which there is a great demand, will consist of a series of 30 adjoining sheets which can be bound as an atlas. The sheets cover one degree north to south and two degrees west to east. (See fig. 2.)

Although most of the available geologic material has now been compiled for all 30 sheets, at present only eight are being prepared for publication, covering a large area in southern California. These will be issued as preliminary advance sheets without color, subject to correction. Much of the state has not yet been geologically mapped even on so small a scale as 1:250,000.

The compilation is being done by Charles J. Kundert under the immediate direction of Olaf P. Jenkins, who prepared the 1938 issue of the state map.

BASIC GEOLOGIC MAPPING

The Division of Mines' long-range program of basic geologic mapping of the state (largely on quadrangle areas) was continued during the fiscal year 1952-53. Two new geologic reports with detailed geologic maps were released—Saltdale quadrangle and Sebastopol quadrangle. Eight more of this series of colored-lithograph 15-minute quadrangles

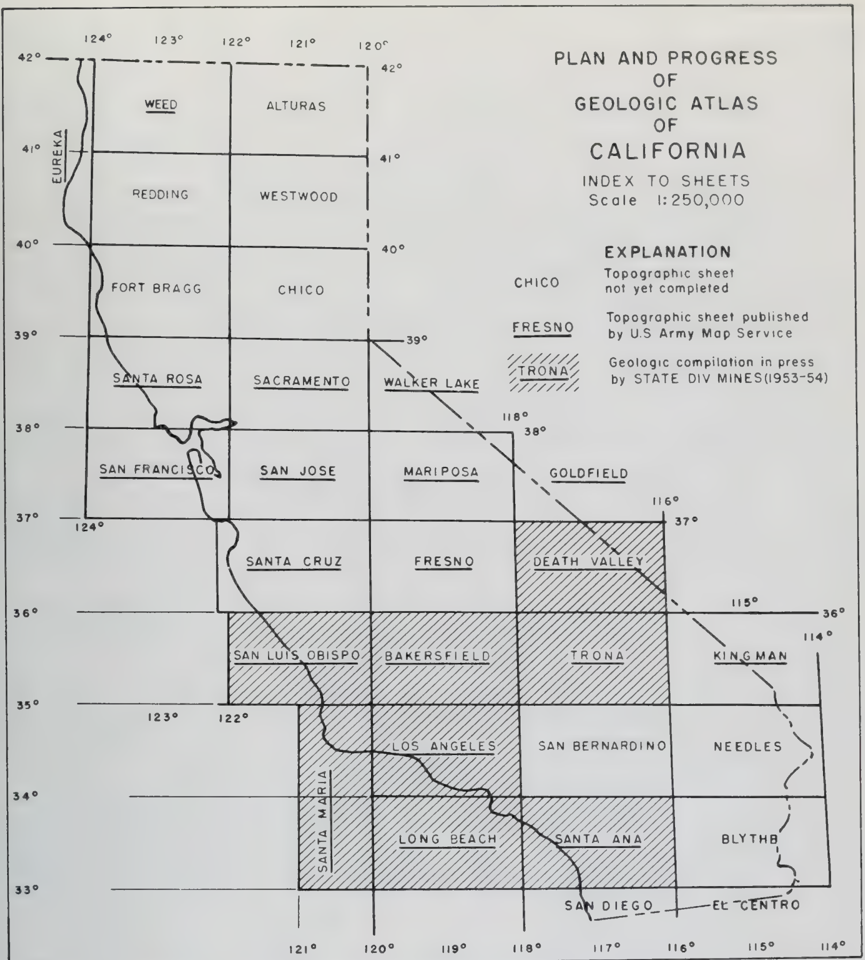

Figure 2. Index map of California showing plan and progress of geologic atlas sheets.

were in press at the close of the fiscal year, and 85 additional quadrangles were in preparation. The previously published geologic maps of this series continued to be in great demand by petroleum and mining companies carrying on exploration programs, as well as by engineers, agriculturists, and the scientifically interested public. Supervision of the Division's basic geologic mapping program is the responsibility of Gordon B. Oakeshott.

The geologic mapping of quadrangles is done in large part by research geologists (professors or graduate students) affiliated with universities. In some cases the mapping is done by private research geologists or geologists who may be affiliated with geological departments of exploration companies. Detailed mapping of the geology and mineral deposits of quadrangles is also being done by the U. S. Geological Survey through a cooperative program.

Staff geologists of the Division of Mines have undertaken geologic mapping of certain quadrangles of particular economic importance. Projects actively under way by the Division include the Barstow 30-minute quadrangle (completed and in press) by Oliver E. Bowen, Jr.; San Fernando 15-minute quadrangle (field mapping and laboratory work completed, report in preparation) by Gordon B. Oakeshott; Matterhorn Peak 15-minute quadrangle (field mapping completed, report in preparation) by Charles W. Chesterman; Shoshone and Tecopa 15-minute quadrangles (field mapping in progress) by Lauren A. Wright.

Within the boundaries of the Barstow quadrangle are numerous nonmetallic and metallic mineral deposits such as limestone, dolomite, ganister, clay, mica, pyrophyllite, silver, lead, gold, iron, and copper. These are the source of a major part of the mineral wealth currently coming from San Bernardino County. Cement is the leading mineral commodity.

San Fernando quadrangle lies in the western San Gabriel Mountains and marginal areas in Los Angeles County. The area is particularly valuable for a number of mineral commodities of current and potential value, including petroleum, limestone and dolomite, graphite, granite rip-rap, titanium ore, rock, sand and gravel, and volcanic ash. The old Elsmere Canyon, Whitney Canyon, and Schist oil fields and the active Placerita oil field are in the western part of the quadrangle.

Matterhorn Peak quadrangle lies in the high Sierra Nevada northwest of Mono Lake. In addition to its great scenic attraction, the area is noted for its gold mines and potentialities for tungsten.

Shoshone-Tecopa quadrangles cover a mountainous desert area, for the most part in Inyo County, southeast of Death Valley. Lead, zinc, silver, gold, talc, saline minerals, pumice, and perlite are among the major economic mineral commodities found in this area.

The following list shows progress of the basic geologic mapping program to July 1, 1953. The quadrangles listed are 15-minute (scale 1 : 62,500), unless otherwise indicated. The letter preceding the name of the quadrangle indicates the affiliation of the geologists who are doing the work:

D—Division of Mines
U—University geologist
S—Federal Geological Survey (cooperative program)
O—Other professional geologist

The symbol (example, H 15) following the quadrangle name serves as a means of locating it on the index map (figure 3).

Recently published geologic map and report.

(U) Antioch (K 16)
(U) Blue Lake (C 5)
(U) Carquinez (J 16)
(S) Cuyamaca Peak (F′ 37)
(O) Gaviota (R 31)
(U) Healdsburg (G 14)
(U) Jamesburg (L 23)
(U) Lebec, 7½-min. (W 29)
(O) Lompoc (Q 30)
(O) Los Olivos (R 30)
(U) Macdoel, 30-min. (I 1, I 2, J 1, J 2)
(U) Mare Island (I 16)
(U) Mount Vaca (J 15)
(S) Neenach (X 29)
(U) Petaluma (H 16)
(O) Point Arguello (P 30)
(O) Point Conception (Q 31)
(U) Point Reyes (G 16)
(U) Quien Sabe (N 21)
(O) Saltdale (A′ 27)
(U) San Benito (N 22)
(U) San Jose (E½)—Mt. Hamilton (W½) (KL 19)
(U) San Juan Bautista (L 21)

(U) Santa Rosa (H 15)
(U) Sebastopol (G 15)
(U) Sonoma (I 15)
(U) Tesla (L 18)
(U) Vacaville (K 15)

Geologic map published, report in preparation.

(U) Copperopolis (P 17)
(U) Hollister (M 21)
(O) Lake Elsinore (C′ 34)

Geologic map and report in press.

(D) Barstow 30-min. (C′ 29, C′ 30, D′ 29, D′ 30)
(O) Breckenridge Mt. (X 27)
(U) Ferndale (A 6)
(U) Fortuna (B 6)
(U) Lower Lake (H 13)
(U) Ortigalita Peak (O 21)
(S) San Andreas E. (P 16)
(S) Sonora N.W. (Q 17)
(S) Sutter Creek S.E. (O 15)

Geologic map and report nearly ready for press.

(U) Dardanelles Cone (S 15)
(U) Desert Creek Peak (U 14)
(D) San Fernando (Y 31)
(S) Santa Catalina Island (X 35, Y 35)
(U) Santa Ysabel (F′ 36)
(U) Sonora Pass (T 15)
(S) Ubehebe (B′ 22)
(U) West Mono Lake (U 16, 17)
(U) Wheeler Peak (U 15)

Geologic map completed, report in preparation.

(S) Big Pine (Y 20)
(S) Bishop (Y 19)
(S) Casa Diablo Mt. (X 18)
(U) Ebbett Pass (S 14)
(O) Fremont Peak (C′ 28)
(S) Mt. Goddard (X 20)
(S) Mt. Tom (X 19)
(D) Matterhorn Peak (U 16)
(S) New Almaden (K 20)
(S) New York Butte (A′ 22)
(O) Opal Mt. (D′ 28)
(U) St. Helena (I 14)
(S) San Andreas (P 16)
(S) Shasta Copper Belt (I 5, 6)
(U) Sutter Creek (O 15)
(U) Topaz Lake (T 14)

In preparation, field work completed or nearly completed.

(U) Adelaida (O 26)
(U) Bradley (O 25)
(U) Bryson (N 25)
(U) Capay (J 14)
(U) Cape San Martin (M 25)
(U) Carbona (M 18)
(U) Cholame, 30-min. (Q 25, Q 26, R 25, R 26)
(U) Cuyapaipe (G′ 37)
(O) Imperial Valley quadrangles
   Agua Dulce (H′ 35)
   Barrel Spring (H′ 36)
   Brawley (J′ 37)
   Carrizo Mt. (H′ 37)
   Coyote Wells (H′ 38)
   Durmid (I′ 35)
   Heber (J′ 38)
   Kane Spring (I′ 36)
   Plaster City (I′ 37)
(D) Masonic Mt. (V 15)
(U) Nipomo (Q 28)
(U) Orestimba (N 19)
(U) Paso Robles (P 26)

In preparation.

(U) Banning (E′ 33)
(D) Bodie (V 16)
(U) Blairsden (P 9)
(U) Branch Mt. (R 28)
(S) Darwin (B′ 23)
(S) Devils Post Pile (V 18)
(U) Halfmoon Bay (I 19)
(O) Hernandez Valley (O 23)
(U) Indian Gulch (R 19)
(U) Joaquin Rocks (Q 23)
(U) King City (N 24)
(U) La Panza (R 27)
(U) Ladoga (I 11)
(U) Lucerne Valley (E′ 31)
(U) Merced Falls (Q 18)
(S) Mono Craters (V 17)
(S) Mt. Morgan (W 18)
(U) Mt. Stanford (W 19)
(S) New Almaden (K 20)
(O) New Idria (P 23)
(U) Oroville (L 10)
(U) Palo Alto (J 19)
(U) Perris (D′ 33)
(U) Priest Valley (O 23, 24, P 23, 24)
(U) Reiff (I 13)
(U) Rumsey (J 13)
(U) Shadow Mts. (B′ 30)
(S) Shasta Copper Belt (H 6, I 6, J 6)
(D) Shoshone (G′ 25)
(D) Tecopa (H′ 25)
(U) Triunfo Pass (W 32)
(U) Wilbur Springs (I 12)

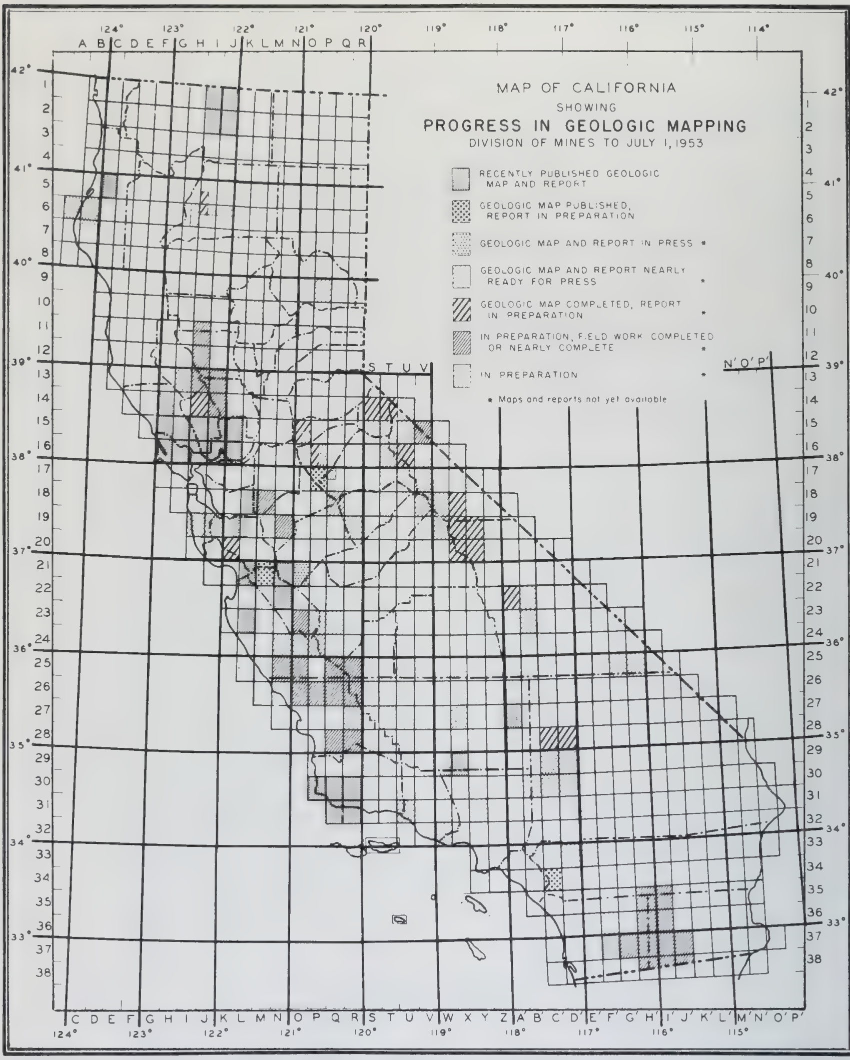

FIGURE 3. Index map of California showing progress in quadrangle geologic mapping

MINERAL COMMODITY SURVEYS

Public Resources Code:

"2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State."

It has been found necessary that the Division of Mines keep informed of the most important facts concerning the mineral commodities of the state—their occurrence, development, uses, and potentialities. Among the entire staff all the different commodities are assigned as continuous studies. The staff members are required to keep in touch with commodity specialists of the federal Bureau of Mines and Geological Survey. An important program now under way is the revision of Bulletin 156, *Mineral Commodities of California.* To realize the extent of these studies is to review the list of mineral commodities which must be covered in this volume:

Mineral fuels

Coal and lignite
Natural gas
Petroleum
Peat

Nonmetallic industrial minerals

Abrasive minerals
Andalusite, kyanite, and sillimanite
Arsenic
Asbestos
Asphalt and bituminous rock
Barite
Beryllium
Black sands
Calcite (optical)
Carbon dioxide
Cement
Clays
Diatomite
Dimension stone, including slate
Dolomite
Feldspar
Fluorspar
Gemstones
Graphite
Lime and limestone
Magnesite, magnesium, and magnesium compounds
Mica
Nitrogen compounds
Pebbles for grinding
Phosphates
Pumice, pumicite, and perlite
Pyrites
Quartz crystal
Salines
- Boron
- Bromine
- Calcium chloride
- Gypsum
- Iodine
- Lithium
- Potassium salts
- Salt
- Sodium carbonate
- Sodium sulphate

Sand, gravel, and crushed rock
Silica
Strontium minerals
Sulfur and sulfuric acid
Talc, soapstone, and pyrophyllite
Wollastonite

Metals

Aluminum
Antimony
Bismuth
Cadmium
Chromite
Cobalt
Copper
Gold
Iron (including ferro-alloys and coke)
Lead
Manganese
Mercury
Molybdenum
Platinum and allied metals
Silver
Tin
Titanium
Tungsten
Uranium, thorium, germanium, and rare earth elements
Zinc
Zirconium

Comprehensive reports have been issued by the Division on some of the important mineral commodities, while surveys on others are in progress. Publications on iron, manganese, chromite, copper, quicksilver, and tungsten represent extensive statewide surveys done in cooperation with the U.S. Geological Survey. A bulletin on gypsum, prepared by William E. Ver Planck, a member of the Division's staff, was published in 1952.

It is not possible for one person in one year to complete a statewide comprehensive report on any one significant commodity. Therefore, only a few of the more important minerals are currently being thoroughly investigated.

Gypsum. The statewide survey on gypsum was completed and published in October 1952 as Bulletin 161, *Gypsum in California*, by William E. Ver Planck. The geologic occurrence and origin of gypsum are covered, and three of the most important gypsum deposits are mapped in detail. The bulletin includes, in addition, sections on the methods and costs of mining, processing, and the marketing of gypsum.

The whole program of the study of gypsum and saline minerals by the Division is being undertaken by William E. Ver Planck. The value of gypsum to California agriculture and salines to all manner of chemical industries is tremendous and of increasing importance.

Common Salt. During the year, work continued on the statewide survey of common salt. Results of core drilling in Danby Lake have been made available by the Metropolitan Water District of Southern California. The Leslie Salt Company, as well as the smaller salt producers, have furnished detailed engineering data concerning the production of salt. The section on the geologic occurrence has been nearly completed, and a report has been prepared in rough draft form. Operations in southern California and in the desert have been visited, and preliminary reports are on file.

Boron. A statewide survey of the boron minerals was initiated with the objective of assembling all existing information that is scattered through the literature. A short article on the uses of boron minerals was published in August 1952 in *Mineral Information Service.* A history of the borax industry was completed in rough draft form, and a section on the geologic occurrence of the boron minerals is in preparation.

Other Saline Minerals. Visits to plants producing other saline minerals have been made in order to keep in touch with developments. Preliminary reports of operations visited have been prepared and are on file. A short article on lithium minerals and the recovery of lithium carbonate by the American Potash & Chemical Corporation is in press.

Strontium. A report on strontium, prepared by the U.S. Geological Survey, was in press during fiscal 1952-53.

Talc. Reports on talc resources, prepared both by the cooperative program with the U.S. Geological Survey and by Lauren A. Wright of the Division of Mines, have been issued, and other reports are to come.

Lead and Zinc. Field work on lead and zinc represent current work of the U.S. Geological Survey cooperative program. Also, a statewide economic map on lead and zinc is being prepared by J. Grant Goodwin of the Divison of Mines.

Massive Sulfides. A geological examination of the massive sulfide deposits (pyrite) of Island Mountain in northwestern California has been completed by Melvin C. Stinson.

Asbestos. Important potential deposits of asbestos are currently being investigated by Salem J. Rice of the Division of Mines.

Clay. The Division's statewide investigation of the clay resources of California was particularly active during the fiscal year 1952-53. The work was carried on by Mort D. Turner in close cooperation with Professor Joseph A. Pask of the Ceramic Engineering Laboratories of the University of California. One result of this is Special Report 19, *Geology and Ceramic Properties of the Clays of the Ione Formation, Buena Vista Area, Amador County, California,* which has led to new prospecting in the area by clay companies and the discovery of several promising deposits of refractory clay.

Continued field and laboratory work are currently in progress by the Division of Mines and the Ceramic Engineering Laboratories on the following clay studies: (1) geology of the ceramic clays of the Alberhill area, Riverside County, (2) clay resources of San Diego and Imperial Counties, (3) geology of the ceramic clays of western Amador County, and (4) ceramic properties of the type clays of the Ione formation. In addition, a study of the geology of the bentonite clay deposits of the Vallecitos area, San Benito County, is being made in cooperation with the United States Bureau of Mines.

During the fiscal year a technical meeting was called in Berkeley and attended by 250 specialists in various fields of clay research and industrial application, from various parts of the United States. As a result, a symposium of 25 papers was assembled and prepared for publication as a bulletin by the Division of Mines, covering basic technical data on clay technology.

Lightweight-Aggregate Material Investigations. Following World War II, there arose a tremendous demand for lightweight-aggregate building materials. As a result of demands by the building industries, a commodity study of perlite, pumice, pumicite, and volcanic cinders was initiated in 1947 by the Division of Mines to determine the availability of these lightweight-aggregate materials in California. This investigation, conducted by Charles W. Chesterman, has been statewide in scope and the data obtained have been in part published by the Division in the Journals, two bulletins, and two issues of *Mineral Information Service.*

During the course of field investigations, 25 perlite, 55 pumice, 10 pumicite, and 5 volcanic cinder deposits were examined. The field work has now been completed, and final reports describing these materials, their utilization, and technology, are being prepared.

Thus far, this investigation has done much to stimulate national interest in these materials and has added considerably to the economic development of the state. For example, published results of a reconnaissance investigation of the perlite deposits in Napa and Sonoma Counties has led to the establishment of two successful perlite operations in Napa County: one that mines and processes perlite, and the other that mines and prepares the perlite for processing only. In addition, considerable data have been given orally to persons interested in locating deposits of these materials in California.

Limestone and Dolomite. A continuous program of study on limestone and dolomite has been assigned to Oliver E. Bowen, Jr. who is undertaking field mapping and sampling of large deposits of potential value. The largest consumer of limestone is the eighty-million dollar cement industry. Other major consumers are beet-sugar, lime, and chemical industries. Dolomite is a raw mineral used in producing magnesia refractories necessary for kiln and furnace linings. A geological investigation, including the preparation of a geologic map, has been completed of the Cool-Cave Canyon limestone deposit in the Mother Lode country by William B. Clark and Denton W. Carlson.

Petroleum. Petroleum, natural gas, and related products constitute over four-fifths of the current value of California's mineral production. In 1952, production of crude oil in California again established a new record. The Division of Mines serves this great petroleum industry largely by supplying information on basic and regional geology, which is necessary in the exploration program of the industry. The geologic services of the Division are appreciated by more people in the petroleum industry than any other mineral industry in the state. Hundreds of oil geologists secure and use the geologic maps and reports of the Division. Gordon B. Oakeshott supervises this technical work of the Division, including all the mineral fuels.

The publications of the Division particularly used by the oil and gas industry are: Bulletin 118, *Geologic formations and economic development of the oil and gas fields of California,* issued in 1943; the maps and reports of the geologic quadrangle map series; maps and reports of smaller areas published in various other bulletins in the Special Report series; and in the California Journal of Mines and Geology. Bulletin 118 was reprinted in 1948; however, the low stock remaining in July 1953 indicates a third printing may be necessary, though the bulletin is now out of date. Separate chapters of this bulletin are gradually being revised from time to time by papers which appear in the Special Report series, and for this reason it is not contemplated that the volume as a whole will soon be revised. For example, revision of a major section of Bulletin 118 was issued during the past year as Special Report 23, *Exploratory Wells Drilled Outside of Oil and Gas Fields in California to December 31, 1950 (including an outline geologic map of the state showing outlines of the oil and gas fields and exploratory holes).*

A list of references to Division of Mines literature published since 1943, bearing particularly on petroleum geology, follows:

Special Reports

6 Geology of Bitterwater Creek area, Kern County, California, 21 pp., 1951.

9 Type Moreno formation and overlying Eocene strata on the west side of the San Joaquin Valley, Fresno and Merced Counties, California, 29 pp., 1951.

15 Photogeologic interpretation using photogrammetric dip calculations, 21 pp., 1952.

18 Geology of the Whittier-La Habra area, Los Angeles County, California, 22 pp., 1952.

19 Geology and ceramic properties of the Ione formation, Buena Vista area, Amador County, California, 39 pp., 1952. (Includes stratigraphy of type Ione formation.)

21 Geology of Burruel Ridge, Orange County, northwestern Santa Ana Mountains, California, 1952.

23 Exploratory wells drilled outside of oil and gas fields in California to December 31, 1950, 77 pp., 1952.
24 Geology of the Lebec quadrangle, Kern, Los Angeles, Ventura Counties, 23 pp., 1952.
26 Geology of the southern Ridge Basin, Los Angeles County, California, 11 pp., 1952.
30 Geology of the southern part of the Quail quadrangle, California, 18 pp., 1953.

Bulletins

118 Geologic formations and economic development of the oil and gas fields of California, 773 pp., 1943 (2d printing 1948).
133 Geology of the San Juan Bautista quadrangle, California, 112 pp., 1946. (Sargent oil field, pp. 73-74.)
140 Geology of the Tesla quadrangle, California, 75 pp., 1948. (Oil seeps, pp. 64-67.)
143 Geology of the Hollister quadrangle, California (geologic map only).
147 Geology of the Quien Sabe quadrangle, California, 60 pp., 1949.
149 Geology and mineral deposits of an area north of San Francisco Bay, California, 135 pp., 1949 (oil and gas, pp. 92-94).
150 Geology of southwestern Santa Barbara County, California, 95 pp., 1950. (Includes Capitan, Lompoc, and Zaca oil fields, and Refugio gas fields.)
154 Geologic guidebook of the San Francisco Bay Counties, 392 pp., 1951. Part 5, Mineral industry—mineral fuels of the San Francisco Bay Counties, pp. 223-230.
156 Mineral commodities of California, 1950. Petroleum, pp. 85-108; liquefied gas, pp. 80-83; natural gas, pp. 66-79.
164 Geology of the Eel River Valley area, Humboldt County, California, in press, 1953. (Includes Eureka (Tompkins Hill) gas field.)

California Journal of Mines and Geology

July 1943: "Carbon-dioxide gas occurrences in Mendocino and northern Sonoma Counties," pp. 301-309; "Notes relating to Sutter Buttes gas field," pp. 377-381.
April 1948; pp. 129-158, "The basement complex in well samples from the Sacramento and San Joaquin valleys, California."
April 1949; "Water-flooding as a method of increasing California oil production (Part I)" pp. 123-202; "Mineral resources of Kern County," pp. 203-297.
July 1949; pp. 363-416 "Water-flooding as a method of increasing California oil production (Part II)."
October 1949; pp. 541-551, "Water-flooding as a method of increasing California oil production (Part III)."
January 1950; pp. 43-79, "Geology of the Placerita oil field, Los Angeles County, California"; pp. 83-141, "Mines and mineral resources of Sonoma County."
April 1950; pp. 191-212, "Geology and oil prospects of western San Jose Hills, Los Angeles County, California."
July 1951; pp. 485-552, "Mines and mineral resources of Fresno County, California."
October 1951; pp. 561-617, "Mines and mineral resources of Contra Costa County."
January 1952; pp. 29-53, "Mines and mineral resources of Glenn County, California."
July 1952; pp. 207-251, "Mines and mineral resources of Merced County."

KLAMATH MOUNTAINS SURVEY

For a long time there has been a great need for basic geologic mapping in the Klamath Mountains. This is one of the highly mineralized areas of California, yet one in which the geology is still virtually unknown. The Division of Mines has initiated a study, first to accumulate basic geological information on the Klamath Mountains available through studies of mineral commodities; second, to log the geology along the principal roads.

The mineral commodities of the Klamath Mountains requiring special study consist of the following:

(1) Minerals produced
- Gold and platinum
- Copper
- Mercury
- Chromite
- Manganese
- Pyrite
- Sand and gravel

(2) Potential mineral resources
- Oil and gas
- Asbestos
- Limestone and dolomite
- Magnesium
- Clays
- Building materials
- Scheelite
- Iron
- Nickel

During the summer and fall of 1952, Salem J. Rice mapped by reconnaissance methods the geology of five quadrangles on the western flank of the Klamath Mountains along the coast between Eureka and the Oregon border. These quadrangles are the Eureka, Trinidad, Orick, Requa, and Point St. George. In conjunction with this mapping, a study was made of known and potential mineral resources of the area. It is intended that the results of this work will be published by the Division in the form of a geologic guidebook.

INVESTIGATION OF EARTHQUAKES

On July 21, 1952, the towns of Arvin and Tehachapi, in Kern County, in the southern part of the San Joaquin Valley and southern Sierra Nevada, respectively, were severely damaged by one of the strongest of the many earthquakes California has experienced. This earthquake resulted from an abrupt displacement along the White Wolf fault which trends northeast along the margin of the valley at the base of Bear Mountain. Surface cracking on the valley floor and along the trace of the fault was evident. On August 22 a second major earthquake damaged Bakersfield. The Division of Mines began an immediate investigation of the geological aspects of the earthquakes and completed a program of geologic mapping of rock formations and structure in the area which had begun some time before the first shock. The Division enlisted the cooperation of a large number of geologists, seismologists, and engineers to coordinate their studies with the objective of publishing a more or less complete account of the series of earthquakes in bulletin form. Three major aspects of the earthquakes are covered in papers by some 35 authors, each a specialist in his field. Part I of the bulletin comprises maps and papers discussing the principal geological features and particularly the White Wolf fault zone in relation to geologic structure of the area; Part II deals with the seismology of the area and 1952 earthquakes and includes a detailed analysis of the records obtained by seismographs; Part III summarizes the damage to buildings, railroad, and other engineering structures. Scientific papers contributed have come principally from geologists, seismologists, and engineers of the following agencies which cooperated: American Society of Civil Engineers, California Institute of Technology, California Division of Highways, California Division of Water Resources, Intex Oil Company, Pacific Gas and Electric Company, Richfield Oil Company, Southern Pacific Railroad, Stanford University, Union Oil Company, University of California (Santa Barbara), U.S. Coast and Geodetic

Survey, U.S. Geological Survey (Engineering Branch, Groundwater Branch, Mineral Deposits Branch). By July 1953 most of the contributed papers had been received by the Division of Mines.

MINERAL UTILIZATION SURVEY

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

Results of the direct attack on the problems of mineral utilization, initiated 2 years ago, emphasize and confirm the complexity and the importance of the subject. New uses for mineral materials are evolving constantly, specifications for materials are never static, and abundant supplies of unused raw materials are channeled into productive enterprises when the existence and properties of the materials are made known. The knowledge gained by the studies of mineral utilization enable the Division

(1) To guide consuming industries to available sources;
(2) To direct producers to potential markets;
(3) To emphasize the value and necessity of mineral beneficiation as a means of marketing acceptable products.

Such knowledge is likewise invaluable to the Division of Mines as a guide for starting new projects in critical areas and on currently important commodities.

Mineral utilization data are accumulated by a few staff members assigned principally to that work, by other staff members in the course of commodity studies and other assignments, and by contributions from industry. Information from the industry is obtained by questionnaires, plant visits, telephone calls, and compilation of published and unpublished data. This state-wide survey is being carried on under the supervision of L. A. Norman, Jr.

Mineral utilization studies have been most active in the following counties:

County	*Cooperative agencies*
Alameda	Oakland Chamber of Commerce
Monterey	Salinas Chamber of Commerce and Monterey County Industrial Development, Inc.
Los Angeles	Los Angeles Chamber of Commerce
Orange	Associated Chambers of Commerce of Orange County, Inc.
Sacramento	Sacramento Chamber of Commerce
San Bernardino	San Bernardino County Chamber of Commerce
San Diego	San Diego Division of Natural Resources and San Diego Chamber of Commerce
San Joaquin	Stockton Chamber of Commerce
Santa Clara	San Jose Chamber of Commerce

Coverage will be extended to all counties as personnel becomes available and time permits. More than 5300 questionnaires have been sent to date, and many hundreds of plants have been visited.

After the information is assembled from various sources, it must be processed to give it pertinent and authoritative meaning. The final results of mineral utilization surveys are published as soon as possible in order to make the data available to the largest audience. However, extensive utilization data are being accumulated to answer the many inquiries by correspondence, interviews, and telephone calls. Contributions in the field of mineral utilization from the Division of Mines staff and from industry have been published in various Division of Mines publications. They include the following industries: agriculture, beet sugar, bituminous-base roofing, cement, ceramic, chlorine-caustic, dimension stone, fertilizer, glass, glass container, glazed wall tile, paint, paint and varnish, perlite, petroleum, pulp and paper, pumice, rubber, and quicksilver. In addition, articles on specific commodities, and general utilization and marketing data have appeared from time to time, as well as current mineral and metal market quotations.

Summaries of some of the work to date, prepared by various authors, have appeared in *Mineral Information Service* during the year, and include: *Adsorbent clay, Clay research as an aid to industry, Minerals in the glass industry,* and *Production of glazed wall tile in southern California.* A more detailed report on *California talc in the paint industry* appeared in the *California Journal of Mines and Geology.* An extensive summary of gypsum uses and marketing was included in Bulletin 163, *Gypsum in California.*

SURVEY OF MINING ACTIVITIES

Public Resources Code:

"2208. The State Mineralogist or a qualified assistant may at any time enter or examine any and all mines, quarries, wells, mills, reduction works, refining works, and other mineral properties or working plants in this State in order to gather data to comply with the provisions of this chapter."

A current inventory of mining activities is maintained by the Division of Mines. It consists of information gathered during the course of all field work—field data obtained for the annual review of the mineral commodities, and data resulting from the more detailed studies of the mines and mineral resources of the counties. Reports on the latter are published as a regular feature in the *California Journal of Mines and Geology.*

During the 1952-53 fiscal year, reports on Merced, Del Norte, and San Bernardino Counties appeared. The report on San Bernardino County was the longest and most detailed of any county report published to date, reflecting the size of the largest county in California and its position as the largest mineral producer of the state in quantity (excluding petroleum and natural gas) and in variety of commercial minerals.

Work has been completed and manuscripts submitted for reports on Amador, Mendocino, and Santa Clara Counties. Field work has been completed in Los Angeles County, and is underway in Sacramento, San Joaquin, Monterey, and San Diego Counties. These inventories of mining activities are being carried on under the supervision of L. A. Norman, Jr.

ORE BUYERS' LICENSES AND INSPECTION

Public Resources Code:

"2250. It is unlawful for any person to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing, or receiving for sale, ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets, or specimens without first procuring the license provided for by this chapter."

"2253. The application for a license to carry on such business shall be made to the State Mineralogist . . ."

"2267. Every licensee under this chapter shall file monthly with the State Mineralogist a report of all purchases made under this chapter. The reports shall be made upon forms prescribed by the State Mineralogist and shall contain the information required by this chapter."

Seventy-two ore-buyers' licenses were issued by the Division of Mines, 38 of which were limited licenses (limits the buyer to $1,000 in purchases during the calendar year) and 34 of which were unlimited licenses (no limit on purchases).

Cooperation with local and federal agencies in the investigation of suspected ''high-grading'' activities (gold thefts and illegal transactions) were continued.

LOS ANGELES BRANCH OFFICE

Demands upon the Division's office in Los Angeles are continually increasing, because of the rapid industrial growth of southern California, the expanding markets for raw mineral materials, and the unlimited potential and developed nonmetallic mineral resources of that part of the state. The office maintains a technical personnel of six mining geologists; Lauren A. Wright is in charge.

The increase in public demands were met by increase in information services, indicated as follows:

	1949-50	*1950-51*	*1951-52*	*1952-53*	*Percent increase*
Total pieces of correspondence	1,579	2,177	3,921 *	6,049 *	54
Total pieces of free publications	6,211	6,035	4,721	8,641	83
Mineral Information Service subscribers		563	1,025	2,143	109
Total number of telephone calls	7,362	7,663	6,973	7,739	11
Visitors			5,345	5,630	6
Total pieces of publications sold	2,787	3,086	4,744	6,217	31
Total value of publications sold	$4,001	$4,129	$4,919	$5,800	18
* Includes Mineral Utilization Survey correspondence			1,497	2,450	

The close integration of the work of the Los Angeles office with the work of the Division as a whole is indicated by the following examples:

(1) The forthcoming revision of the Division's bulletin on *Mineral Commodities of California*, prepared by the entire staff of the Division, is being technically edited by Lauren Wright.

(2) The forthcoming Division bulletin on *Geology of Southern California*, prepared for the Geological Society of America under the editorship of Richard H. Jahns, professor of geology of the California Institute of Technology, will contain several contributions by staff members of the Division: Bennie W. Troxel and Lauren A. Wright of the

Los Angeles office; and Charles W. Jennings, Gordon B. Oakeshott, Charles W. Chesterman, and L. A. Norman, Jr., of the San Francisco office.

(3) The Division's survey of mineral utilization is being done in large part by Richard M. Stewart and Samuel R. Hoffman of the Los Angeles office for the region of southern California.

(4) State survey of sand and gravel has just been started by Thomas E. Gay, Jr., of Los Angeles.

(5) Indexing of the Division's bulletin on mining law is being done by R. J. Sampson of Los Angeles.

(6) Surveys of mining activities of the counties in southern California are made largely by the Los Angeles office staff. San Bernardino County and Los Angeles County are recent notable examples.

(7) Special mineral commodity studies such as on talc, tungsten, and wollastonite are made by the staff of the Los Angeles office.

(8) Occasionally, leading articles for *Mineral Information Service* were prepared in the Los Angeles office.

(9) Report on mineral resources of the Colorado River Basin for the Regional Water Pollution Control Board was prepared by the Los Angeles office.

SACRAMENTO BRANCH OFFICE

The close proximity of the Division's Sacramento office to headquarters in San Francisco affords the branch office personnel the opportunity of frequently making use of facilities in the main office. Technical supervision is by Oliver E. Bowen, Jr., of San Francisco. Two resident mining geologists, Denton W. Carlson and William B. Clark, are in charge of the Sacramento office. Their report shows an increase in activities of information service over last year as follows:

	1951-52	*1952-53*	*Percent increase*
Total pieces correspondence	996	1,086	9
Total number telephone calls	556	591	6
Total number office visitors	842	1,042	24
Totals	2,394	2,719	13

Many of the inquiries received at the office concern gold mining in California. Over eight hundred dollars worth of the Division's publications was sold during each of the last 2 fiscal years.

Technical reports prepared by members of the staff included surveys on mining activities in Amador, Sacramento, and San Joaquin Counties; mineral commodity survey reports on limestone of Cool-Cave Valley, tungsten, and gold. A contribution on gold was made to *Mineral Information Service.*

REDDING BRANCH OFFICE

The Division's office in Redding maintains one technical employee, J. C. O'Brien, who reports the following office activities for the 1952-53 fiscal year:

Total pieces of mail	379
Telephone calls	715
Visitors for interviews	985
Publications sold	293
Names for Mineral Information Service mailing list	312

Some of the most frequent inquiries of the Redding office concern identification of minerals, mining law, government aid and purchasing programs, markets, publications, maps, and minerals, mining, ore dressing, and land classification.

The Redding office was shared with federal geologists working on local projects in cooperation with the Division of Mines.

A new mineral exhibit donated by Dr. George Grotefend was put on display. Other mineral exhibits were established at Shasta Dam Vista House and Shasta County at the State Capitol.

Field surveys of mining activities were, in particular, on Del Norte and Mendocino Counties. Surveys of the mineral commodities copper and zinc were also carried on.

CONCLUSION

The present scope of the activities of the Division of Mines is broader than it has ever been before. These activities represent functions outlined by the Public Resources Code. The Division's surveys and research have given it a wider background to meet authoritatively a larger number of inquiries and demands of the public. This work should continue indefinitely, to keep in step with the industrial growth, the scientific achievements, and the changes in the economic trend of the mineral industry. The surveys cover basic geology, mineral commodities, mining activities, mineral economics, and mineral utilization.

Specifications for grade of minerals to meet the requirements of industry, methods of treatment of minerals to improve their grade, methods of extraction of minerals from the ground, cost figures, and markets, are all subjects of public inquiries. To answer all these queries authoritatively will, however, require additional research and surveys. The facilities and personnel to carry on this work are not yet entirely adequate.

The Division's activities and services have materially increased even though its support has remained practically unchanged except to meet increased costs. Staff members are continually getting better trained and the Division is operating on a more efficient basis. Though it is obvious that the broader background of knowledge and experience, gained through research and surveys, has enabled the Division to broaden and strengthen its services, it is not possible to measure the value of the Division's services in dollars. It is a fact, however, that the Division of Mines has materially contributed to the state's ability to produce annually over one billion dollar's worth of raw mineral materials.

The Division has also materially contributed to the state's ability to develop a multi-billion-dollar manufacturing industry which uses these raw mineral materials. The educational service which the Division renders to the people of the state, and especially to the schools, helps to develop a firm background of knowledge and an interest in the future, as well as present, mineral welfare of the state. It is well known that the development of mineral resources is one of the principal controls of a growing civilization, and the education of youth should not be neglected.

It is herein recommended that the current program of the Division of Mines be continued and permitted to expand with the increasing de-

mands of the people and the needs of their growing industries. The returns to the state are not diminishing but expanding. There are more opportunities now than ever before in the development of the mineral industry, but the trends are changing in emphasis from metals to nonmetals, which should include mineral fuels and salines. Intelligent understanding of the facts together with courage to develop the resources wisely are all that is necessary to greatly increase the wealth of the State of California.

COOPERATIVE STUDIES OF MINERAL DEPOSITS BY THE U. S. GEOLOGICAL SURVEY AND THE CALIFORNIA STATE DIVISION OF MINES

(Fiscal Year 1953)

By Edgar H. Bailey

Cooperation between the California State Division of Mines and the U. S. Geological Survey has resulted in significant contributions regarding the distribution and origin of the many varied mineral deposits found within the State, as well as illustrating the benefits of such cooperation between the States and the Federal Government. The Geological Survey wishes to acknowledge here the numerous courtesies and generous assistance extended by the staff of the California State Division of Mines.

Geologic investigations of mineralized areas in California by the U. S. Geological Survey under the cooperative agreement continued on a somewhat smaller scale during the fiscal year beginning July 1, 1952, the total cost of the work being $101,000 in fiscal 1953 as compared with $111,000 for the preceding fiscal year. The State contributed $35,000 both years. Additional geologic studies conducted in California by the Mineral Deposits Branch of the U. S. Geological Survey involved expenditures that more than equalled the total cost of the cooperative program.

Cooperative Projects. No new cooperative projects were started during fiscal 1953, all funds and time being spent on field, laboratory, and office phases of those already in progress.

Eight cooperative projects were continued from the preceding year: Shasta copper, Mother Lode gold, Sierra Foothills mineral belt, Eastern Sierra tungsten, Bishop tungsten, Darwin lead-zinc, Cerro Gordo lead-zinc, and Ubehebe Peak lead-zinc. Owing to the transfer of the party chiefs to other assignments, very little work was done on the Cerro Gordo and the Ubehebe Peak projects, and therefore only the first six cooperative projects discussed below may be considered active.

Shasta Copper. Work on the large Shasta copper district has continued, being divided between two parties. Work in the western area was completed toward the end of the last fiscal year. The final report on the *Geology and ore deposits of the West Shasta copper-zinc district, California*, has reached advanced stages and now is undergoing final revision by the authors.

Work on the East Shasta district also is rapidly nearing completion. A report on the Afterthought mine has been transmitted to the State Division of Mines. A map, *Geology of the Bully Hill mine area, Shasta County, California*, has been placed on open file, and another map,

East Shasta copper-zinc district, Shasta County, California, has been completed for open-file release. It is hoped that the major report on the entire East Shasta district will be completed next year. Preparation of this report has continued throughout fiscal 1953, as have detailed microscopic studies of rocks and ores from the area. Several important results have evolved from work in the East Shasta area: development of new concepts concerning the genesis of copper-zinc sulfide deposits; development of a comprehensive structural picture of the district; discovery of new data bearing on the age of some of the rock units in the area; and, unraveling of some of the complex problems of the mineralogic, textural, and structural changes brought about by metamorphism of these rocks. The Geological Survey suggested locations for several drill holes in an area north of the old workings at Bully Hill. Subsequent drilling there, under the Defense Minerals Exploration Administration program, resulted in the discovery of a sizable block of ground indicated to contain significant quantities of minable copper and zinc sulfides.

Mother Lode Gold. Final field checks were made, and the maps, tables of mines and prospects, and report for the San Andreas NW quadrangle (7½-minute series) were finished and submitted for review. Among the more significant scientific results during this year were the deciphering of some of the complexly folded and faulted structures that led to the establishment of a detailed stratigraphic section through parts of the Logtown Ridge and Mariposa formations. In the Calaveras formation a new locality for Permian fossils was found. The project is now completed and has been superseded by the Sierra Foothills project, which is concerned with adjacent areas.

Sierra Foothills Mineral Belt. The Sierra Foothills mineral belt project, which was begun late in fiscal 1952, is a continuation and expansion of the Mother Lode project, and in places is coextensive with it. The objectives of the Sierra Foothills project are to determine the geologic environment of the copper, zinc, chromite, and gold deposits of the Sierra Foothills mineral belt and to decipher the regional structure and stratigraphy of the western Sierra Nevada province. The geologic mapping of the 15-minute San Andreas quadrangle has already been completed, as have accurate maps of extensions of the Copperopolis and Bostic Mountain copper-bearing fault zones, and evaluations of two chrysotile asbestos occurrences. Additional thin-section work has proved to be extremely useful in correlation problems, and has resulted in the abandonment of some earlier correlations. Other data were obtained which suggest that faults with a large strike-slip displacement are the dominant structural features of the San Andreas quadrangle, and possibly of the entire Sierra Nevada foothill belt.

Eastern Sierra Tungsten. The first phase of this project was begun about a year ago and is now nearing completion. Work to date has consisted in mapping of the Casa Diablo Mountain quadrangle, including detailed geologic mapping of the surface and some of the underground workings of the Black Rock tungsten mine, and the examination of several inactive mines. Petrographic work has been done on material from the Black Rock mine and other parts of the quadrangle A report on the *Geology and ore deposits of the Casa Diablo Mountain quadrangle* is now in preparation. Scientific and economic contributions already

realized from work in this quadrangle include: accumulation of data pertaining to the principal economic mineral deposits of the area, namely tungsten, gold, and pumice; a generalized geologic map of the quadrangle showing favorable localities for further prospecting; and an understanding of the ore controls in an active tungsten mine—the Black Rock—which is now being further explored under a DMEA contract.

Bishop Tungsten. The geologist assigned to the study of the nationally important tungsten area near Bishop devoted part of the year to this project, as part of his time was consumed in co-authoring two contributions to the geologic guidebook to southern California. Nonetheless, considerable progress was made on two reports pertaining to the Bishop area of about 1,000 square miles, one on the economic geology and one involving a more comprehensive treatment of the geology.

Darwin Lead-Zinc. Mapping of 110 square miles of the northern half of the Darwin quadrangle on a scale of 1:40,000 was completed, and a structure map and geologic sections of the area were prepared. This is an area of notable mineral wealth where little geologic work had been done in the past. A by-product report on the *Geology of the Santa Rosa mine, Inyo County, California,* was published by the State, and considerable work, including a mineralogic study of a suite of ore minerals, was done in connection with maps and reports on other mines in the Darwin area. Among the more important achievements of the project to date are the development of a stratigraphic section and recognition of a general stratigraphic control for most of the deposits.

Cerro Gordo—Ubehebe Peak Lead-Zinc. Work on these two adjacent areas continued on a considerably reduced scale. Examination of specimens and preparation of reports on several mines were, nonetheless, completed, and compilation of a report on the *Economic geology of the New York (Cerro Gordo) quadrangle* was begun. A report on the *Geology and mineral deposits in the Ubehebe Peak quadrangle, Inyo County, California,* was completed, and a supplemental report on the mineral deposits and geology of the Ubehebe Peak area, for publication by the U. S. Geological Survey, was prepared.

Other Cooperative Work. Although no funds were appropriated in fiscal 1953 for the California chromite project, the Geological Survey and the State Division of Mines continued the revision and final preparation of reports on the *Chromite deposits of the southern Coast Ranges, California,* and *Chromite deposits in the northern Sierra Nevada, California.*

Several chapters for the geologic guidebook to southern California are being prepared by Survey personnel. These include a chapter on *Tungsten in southeastern California,* a *Geologic map of the Owens Valley region,* and a chapter on the Mountain Pass area. The guidebook is to be published by the State Division of Mines, and, although in some instances not a direct result, the chapters are by-products of various cooperative projects with the State.

U. S. Geological Survey Activities. In addition to the cooperative investigations with the State, the Geological Survey continued its study of quicksilver deposits. These studies are part of a nationwide appraisal

of quicksilver resources, but, since California is the largest current producer and contains the most significant reserves, the preponderance of the project's time, money, and effort are expended within this State. An important function of this project, aside from primary investigation, is revising and keeping up to date maps and reports on the geology of quicksilver districts. Diamond drilling has been carried on in several places in California, and at the Abbott mine in Lake County exploratory drilling resulted in the discovery and subsequent development of an ore body. Among the accomplishments of the quicksilver studies in California was the discovery of a new mercury mineral ($HgSO_42H_2O$).

The extensive studies of the origin and geologic environment of salines in the Mojave Desert region were continued by the Survey. Although this work does not come under the cooperative agreement, the State will benefit from the extended scope of this investigation of the Geological Survey within California.

Reconnaissance investigations for radioactive materials in California, made by the U. S. Geological Survey on behalf of the U. S. Atomic Energy Commission, included field testing of numerous areas, mine properties, and prospects for anomalous gamma-ray activity. Field testing has been largely confined to parts of San Bernardino, Kern, Riverside, Imperial, and adjacent counties. Detailed mapping of a few of the more promising properties and some mineralogic and petrographic studies have been completed. Several administrative reports have been prepared and transmitted to the U. S. Atomic Energy Commission and a report on the Rosamond uranium prospect, Kern County, was prepared and transmitted to the State Division of Mines for publication. A report describing the known occurrences of radioactive materials in California is now in preparation.

Still another project that in the near future will undoubtedly assume significance in the study of California geology is a preliminary study of the geology and mineral resources of northwestern California. This work consists of geologic reconnaissance mapping of some 15,000 square miles in the largest unmapped area in California. The project was begun near the end of the fiscal year and is being conducted on behalf of the Pacific Central Temporary Field Committee, Department of the Interior.

During World War II a considerable amount of work was done in California by the Federal Government as a part of its Strategic Minerals Investigations program. The results of much of this work were retained and used in file form, but the Survey now is preparing certain manuscripts for publication by the State Division of Mines. *Barite deposits near Barstow, San Bernardino County, California*, for example, probably will be transmitted to the Division early in fiscal 1954, and a report titled *Geological investigations of strontium deposits of southern California* has already been published by the Division of Mines as its Special Report 32.

Some geologists of the Mineral Deposits Branch of the Geological Survey are responsible jointly with staff of the U. S. Bureau of Mines for the field appraisal of deposits for which exploration funds have been requested of the Defense Minerals Exploration Administration. During the year about 50 deposits in California were examined for the DMEA. The normal field examination involves sampling and mapping

in sufficient detail to ascertain the actual or probable presence of ore, and for many deposits the geologists have been able to suggest favorable places for exploration that had not been previously considered. At the year's end, 14 exploration contracts, with a total contract value of more than a million dollars, were in effect in California, and an additional 15 contracts had been completed or terminated. Not only are the geologists responsible for preliminary examinations, but also they make interim inspections during the term of the contract and a final examination when the exploration has been completed. Some of the many examinations required under this program are made by personnel employed specifically for this purpose, but because many of the applications are for exploration of areas with which the regular staff has become familiar in the course of assignments on the cooperative program, many examinations are handled by the members of the regular staff having special familiarity with the area.

The funds to provide this mine evaluation service are made available to the U. S. Geological Survey by the DMEA, and they cover the costs of the examinations made either by geologists assigned to the cooperative program or geologists on a full-time DMEA assignment. The area included in the DMEA region consists of both California and Nevada and the cost of this service in California alone in fiscal 1953 was about $25,000.

San Francisco Office. The San Francisco office, although financed entirely by Survey funds, is essential in the proper functioning of the cooperative agreement with the State. During most of fiscal 1953 the staff, exclusive of DMEA personnel, consisted of three clerk-stenographers, one part-time typist, two draftsmen, and one scientific aide. Their responsibilities include the preparation of texts and illustrations and taking care of correspondence, accounting, supplies, etc., for the geologic staff. During fiscal 1953, 30 reports containing about 2,535 pages and 479 illustrations were handled by the office staff. Fourteen of these reports containing 813 pages and 127 illustrations were transmitted during the year to the State Division of Mines for publication.

CALIFORNIA MINERAL COMMODITIES IN 1951

BY HENRY H. SYMONS * AND FENELON F. DAVIS **

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PRODUCTION OF MINERALS IN CALIFORNIA DURING 1951

Mineral production reached an all-time high in California during 1951, totaling $1,209,428,000. This was an increase of 15 percent over the 1950 production valued at $1,056,047,000, and marked the fourth

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consecutive year during which mineral production in the state exceeded the billion dollar mark. The previous all-time high was made in 1948 with a valuation of $1,146,411,000, according to tabulations compiled by the California Division of Mines in cooperation with the U. S. Bureau of Mines.

In 1951 increases in annual production with all-time highs in quantity and value were shown by boron minerals, cement, diatomite, gypsum, iron ore, lime, limestone, pumice and pumicite, salt, sand and gravel, and talc (including soapstone and pyrophyllite).

Mineral substances showing an all-time high in value of production, were: clay, lead, natural-gas, soda, stone, tungsten concentrates, and zinc.

The quantity of petroleum produced also reached an all-time high in 1951, but the value of this product was considerably below the high mark reached in 1948.

Mineral production in California during 1951.

Commodity	*Short tons unless otherwise stated*	*Value*
Boron mineral	862,797	$20,030,000
Cement (incl. clay used for cement) (bbls. of 376 lbs. net)	28,956,470	77,753,697
Chromite	6,302	490,974
Clay (except for cement), and fuller's earth	1,615,000	3,757,000
Copper (Cu content in pounds)	1,842,000	445,764
Gold (Troy ounces, Au content)	339,732	11,890,620
Gypsum	1,092,883	2,602,758
Iron ore (long tons)	1,183,000	(3)
Lead (Pb content in pounds)	27,934,000	4,832,582
Lime	203,344	3,366,959
Mercury (flasks, 76 pounds Hg)	4,282	899,777
Natural gas (thousand cubic feet)	566,751,000	82,745,000
Natural-gas liquids		
Natural gasoline and cycle products (barrels of 42 gallons)	21,131,950	65,923,000
Liquefied petroleum gases (barrels of 42 gallons)	8,400,774	15,528,000
Peat	6,432	42,016
Petroleum (crude) (barrels of 42 gallons)	354,561,000	797,760,000
Platinum group metals (Troy ounces)	308	38,200
Pumice and pumicite	264,411	1,228,569
Salt	1,275,574	5,261,780
Sand and gravel	46,928,000	41,280,000
Silica (quartz, sand)	79,276	507,265
Silver (Troy ounces, Ag content)	1,145,219	1,036,481
Stone:		
Granite (dimension stone)	8,719	340,231
Limestone [2] (includes dolomite)	1,167,434	3,614,491
Miscellaneous	11,361,199	10,759,802
Talc, soapstone, and pyrophyllite	126,784	2,269,771
Tungsten (concentrates—60% WO_3 basis)	3,007	11,557,325
Zinc (Zn content in pounds)	19,204,000	3,495,128
Other minerals [3]	---	39,970,810
Total value		[1] $1,209,428,000

[1] Revised figures.
[2] Except limestone for cement and lime.
[3] Antimony, asbestos, barite, bromine, calcium chloride, carbon dioxide, coal (lignite), diatomite, feldspar, iodine, iron ore, lithium minerals, magnesite, magnesium compounds, molybdenum concentrates, perlite, potassium salts, pyrite, slate, sodium carbonate, sodium sulfate, sulfur, and titanium concentrates.

Value of mineral output in California by counties in 1951.

County	*Value*	*County*	*Value*
Alameda	$13,296,033	Orange	$97,389,095
Alpine	84,222	Placer	446,819
Amador	1,219,919	Plumas	70,120
Butte	1,354,164	Riverside	18,426,547
Calaveras	5,725,493	Sacramento	22,264,560
Colusa	158,486	San Benito	3,554,012
Contra Costa	1,154,829	San Bernardino	55,529,399
Del Norte	502,714	San Diego	3,381,090
El Dorado	2,030,731	San Francisco	0
Fresno	116,530,747	San Joaquin	3,027,741
Glenn	201,649	San Luis Obispo	10,845,204
Humboldt	1,028,683	San Mateo	6,790,538
Imperial	1,637,612	Santa Barbara	94,117,314
Inyo	18,999,681	Santa Clara	20,357,253
Kern	249,449,434	Santa Cruz	5,650,959
Kings	19,634,393	Shasta	3,269,730
Lake and Tehama	104,108	Sierra	632,551
Lassen	112,577	Siskiyou	526,738
Los Angeles	284,115,599	Solano	10,057,252
Madera	1,240,273	Sonoma	1,523,285
Marin	883,789	Stanislaus	709,411
Mariposa	286,644	Sutter	212,294
Mendocino	253,417	Tehama (see Lake)	---
Merced	543,856	Trinity	308,644
Modoc	244,850	Tulare	1,654,670
Mono	534,757	Tuolumne	1,020,937
Monterey	7,056,310	Ventura	110,437,071
Napa	666,653	Yolo	744,875
Nevada	3,433,285	Yuba	1,941,388

Total	$1,207,374,408
Not distributed	$2,053,592
Grand total	$1,209,428,000

Asbestos. The asbestos mined and shipped during 1951 came from a property in Shasta County. The material was the tremolite variety and was used for acid filters and as a filler. During 1950 asbestos was reported shipped from two properties in Shasta County and one in Inyo County.

Barite. The barite produced and shipped in California during 1951 came from a property in Plumas County, and was used in the manufacture of barium chemicals. The 1950 production of barite came from properties in Kern and Plumas Counties.

Boron Minerals. An all-time high in both quantity and value was reached for shipments of borates in 1951. Shipments from California deposits totaled 862,797 short tons (containing 240,522 tons of B_2O_3) valued at $20,030,000. This was a 33 percent increase over the 1950 output of 647,735 short tons (containing 190,032 tons of B_2O_3) worth $15,890,000. Borate minerals were shipped from two deposits in Inyo County, two deposits in San Bernardino County and a single deposit in Kern County.

Each of the aforementioned counties produced distinctive boron minerals. Colemanite was supplied from Inyo County, kernite and probertite were supplied from Kern County, and San Bernardino County supplied borax from lake brines.

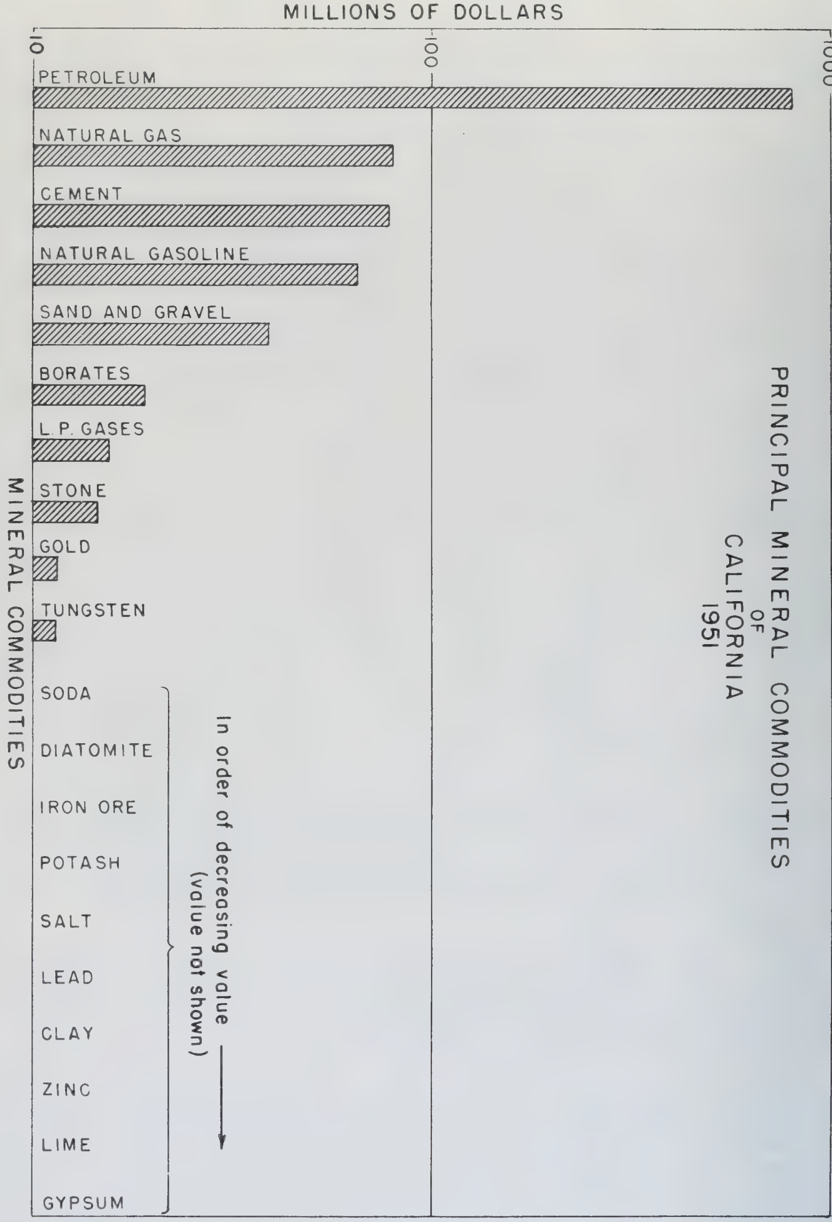

FIGURE 1.

Bromine. The bromine produced in California during 1950 and 1951 came from single properties in Alameda and San Bernardino Counties. The material in Alameda County was recovered from sea-water bitterns purchased from the salt works on San Francisco Bay.

FIGURE 2. Plant of United Materials and Richmond Brick Co., Pt. Richmond, Contra Costa County. View southwest across San Francisco Bay to Angel Island and San Francisco. Line across center of picture is breakwater. *Photo by Mort D. Turner, 1953.*

The San Bernardino County production was extracted from the brines at Searles Lake. Most of the bromine was used in the manufacture of ethylene dibromide for antiknock gasoline. Minor amounts were used in the preparation of photographic emulsions and chemical reagents.

Calcium Chloride. The output and value of calcium chloride shipped in 1951 was the highest on record. Substantial increase in both quantity and value of production was shown over the previous year. Shipments were made from three properties at Bristol Lake in San Bernardino County.

Carbon Dioxide (Natural). Carbon dioxide was produced in 1950 and 1951 from wells near Niland, Imperial County, and Hopland, Mendocino County. Most of the carbon dioxide was used in the manufacture of dry ice. The carbon dioxide gas produced from Imperial County totaled 128,990 thousand cubic feet in 1950 and 108,380 thousand cubic feet in 1951.

Cement. Production and shipments of cement in California during 1951 exceeded all previous years. For 1951 shipments totaled 28,956,470 barrels (of 376 pounds) valued at $77,753,697 as compared with 26,685,004 barrels worth $65,285,675 in 1950. Production in California's 11 cement mills during 1951 totaled 29,918,293 barrels compared with 26,277,209 in 1950.

The five cement mills in northern California (one each in Calaveras, San Benito, San Mateo, Santa Clara and Santa Cruz Counties) during 1951 produced 13,556,921 barrels of cement and shipped 12,973,345 barrels worth $35,866,681, as compared with shipments of 11,797,448 barrels worth $28,167,050 in 1950. The six southern California mills (three in San Bernardino County, and one each in Kern, Los Angeles, and Riverside Counties) produced 16,361,372 barrels of cement and shipped 15,983,125 barrels worth $41,887,016, as compared with shipments of 14,887,556 barrels valued at $33,091,625 in 1950.

The estimated capacity of northern California cement mills as of January 1, 1952 was 13,150,000 barrels, and for southern California mills was 17,720,000 barrels. The estimated capacity for all California mills on January 1, 1950 was 30,870,000.

Chromite. During 1951 chromite was mined and shipped in California from properties in Butte, Del Norte, Fresno, Shasta, and Siskiyou Counties totaling 5,626 long tons worth $490,974. The 1950 output of chromite in California came from a single property in Butte County.

Clay. The crude clay produced in California during 1951 came from 77 pits in 25 counties and totaled 2,584,162 short tons worth $4,532,449. Of this quantity 974,799 short tons worth $974,799 went into the manufacture of cement. The remaining 1,609,363 short tons valued at $3,557,650 were used in the ceramic industry, as oil well drilling mud, as fillers, and for other industrial purposes. During 1950 the production of crude clay totaling 1,454,846 short tons (not including that used in cement) worth $2,904,750 was reported as coming from California properties.

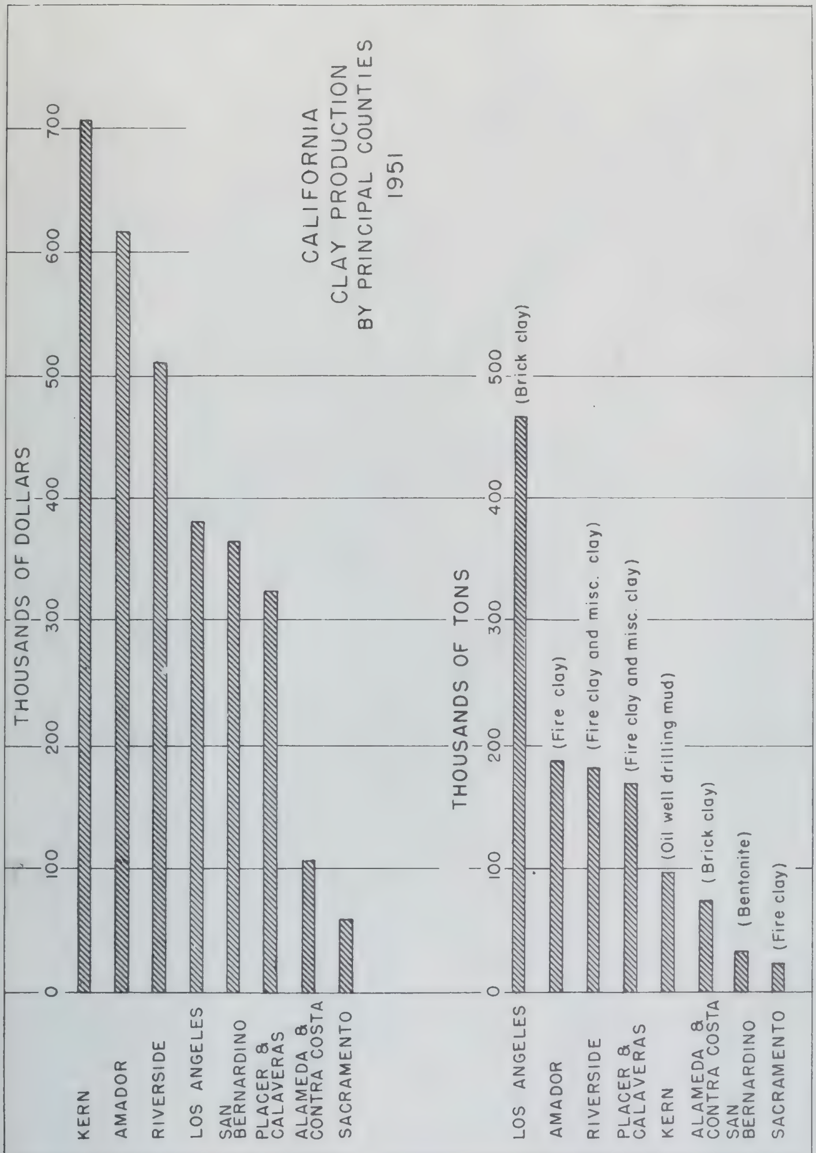
CALIFORNIA
CLAY PRODUCTION
BY PRINCIPAL COUNTIES
1951
THOUSANDS OF DOLLARS
0
100
200
300
400
500
600
700
KERN
AMADOR
RIVERSIDE
LOS ANGELES
SAN BERNARDINO
PLACER & CALAVERAS
ALAMEDA & CONTRA COSTA
SACRAMENTO
THOUSANDS OF TONS
0
100
200
300
400
500
LOS ANGELES
(Brick clay)
AMADOR
(Fire clay)
RIVERSIDE
(Fire clay and misc. clay)
PLACER & CALAVERAS
(Fire clay and misc. clay)
KERN
(Oil well drilling mud)
ALAMEDA & CONTRA COSTA
(Brick clay)
SAN BERNARDINO
(Bentonite)
SACRAMENTO
(Fire clay)

FIGURE 3.

FIGURE 4. Harvey fire clay pit of Western Refractories Co., Carbondale, Amador County. *Photo by Mort D. Turner.*

The 1951 clay output consisted of 510,221 short tons of fire clay (including stoneware clay) worth $1,436,372; 1,069,477 short tons of miscellaneous clay worth $1,617,670; and 29,665 short tons of kaolin, china clay and bentonite worth $503,608.

California clay production by counties in 1951 (not including clay used in manufacture of cement).

County	Short tons	Value
Amador	188,112	$614,223
Kern	96,280	700,620
Los Angeles	466,820	381,148
Riverside	182,101	510,653
Sacramento	20,687	59,811
San Bernardino	32,760	364,331
Alameda, Calaveras, Contra Costa, Fresno, Humboldt, Imperial, Inyo, Marin, Orange, Placer, San Benito, San Diego, San Joaquin, Santa Barbara, Santa Clara, Sutter, Stanislaus, Tulare, and Ventura	622,603	926,864
Totals	1,609,363	$3,557.650

Not included in the above figures for 1951 was a small output of fullers earth which came from separate single properties in Inyo and Kern Counties.

Coal (Lignite). In 1946 work was started on a plant to extract montan wax from the lignite deposits at Ione, Amador County. This plant began operating in 1947 and the company has been mining a small tonnage of coal annually. The montan wax from this plant is used in such products as shoe polish, carbon paper, and as a substitute for carnauba wax. A van dyke brown pigment is also made from coal at this plant and is used in paints and polishes. The plant residue is used as a soil conditioner.

Copper. The recoverable copper produced in California during 1951 totaled 1,842,000 pounds valued at $445,764, as compared with 1,292,000 pounds worth $268,736 in 1950. Most of the California copper was produced as a by-product of base metal mining in Inyo and Shasta Counties. A copper concentrate was made at the Pine Creek mill from tungsten ore. Several small properties in the Mother Lode area mined copper ore. The 1951 copper output by counties is shown in the following table:

Mine production of copper in California, 1951, by counties.

County	Pounds	Value
Amador	14,700	$3,557
Calaveras	487,400	117,951
El Dorado	3,700	895
Inyo	346,400	83,829
Kern	300	73
Madera	1,200	290
San Bernardino	104,400	25,265
Shasta	879,800	212,912
Sierra	100	24
Siskiyou	100	24
Trinity	3,200	774
Tulare	400	97
Tuolumne	300	73
Total	1,842,000	$445,764

FIGURE 5. Open-pit mine with coal beds exposed. American Lignite Products Co., Amador County. *Photo by Mort D. Turner.*

Diatomite. The diatomite mined and shipped in California during 1951 came from the properties of two large companies operating in Los Angeles and Santa Barbara Counties. A small amount was produced also from a single property in Inyo County. The 1951 production was the largest on record both in quantity and value.

Feldspar. The feldspar reported mined and shipped in California in 1950 and 1951 came from a single property in San Bernardino County.

Gold. The California gold output in 1951 totaled 339,732 fine ounces worth $11,890,620, as compared with 412,118 fine ounces worth $14,424,-

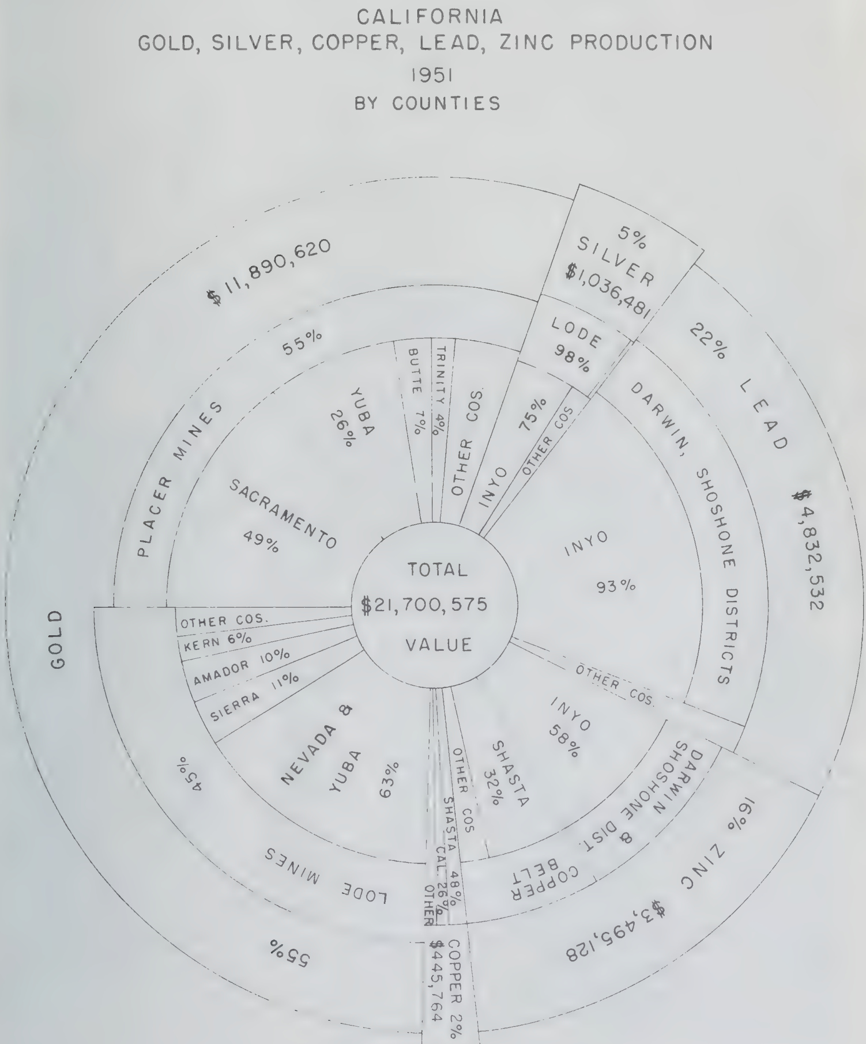

FIGURE 6.

130 in 1950. Of this amount, 152,108 fine ounces was from 173 lode mines and 187,624 fine ounces from 121 placer properties. The gold production in 1951 was from 31 counties.

As in the past Nevada County led the counties in the value of gold output with a total of $3,404,975, followed by Sacramento County with a total of $3,205,475, and Yuba County with $1,706,110. The leaders were followed in turn by Sierra, Amador and Butte Counties. The gold produced from Amador, Nevada, and Sierra Counties came from lode or deep mines; while the production from Butte, Sacramento, and Yuba Counties came chiefly from placer mines, mainly dredges.

Mine production of gold in California, 1951, by counties in terms of recoverable metal.

	Mines producing [1]		Fine ounces		Total	
	Lode	Placer	Lode	Placer	Fine ounces	Value
Alpine	1	--	------	----	----	------
Amador	7	3	15,439	258	15,697	$549,395
Butte	2	6	93	14,060	14,153	495,355
Calaveras	5	5	1,674	1,075	2,749	96,215
El Dorado	8	4	3,373	405	3,778	132,230
Fresno	--	[2]	------	[2]	[2]	[2]
Humboldt	--	2	------	6	6	210
Imperial	2	--	794	----	794	27,790
Inyo	29	1	4,843	3	4,846	169,610
Kern	18	4	8,746	296	9,042	316,470
Los Angeles	3	1	245	65	310	10,850
Madera	2	10	36	581	617	21,595
Mariposa	8	[2] 2	120	[2] 3,082	[2] 3,202	[2] 112,070
Merced	--	1	------	4,768	4,768	166,880
Modoc and Mono	[3] 4	--	944	----	944	33,040
Nevada	[4] 8	14	[4] 95,692	1,593	[4] 97,285	[4] 3,404,975
Placer	1	9	291	428	719	25,165
Plumas	3	3	31	166	197	6,895
Riverside	6	--	37	----	37	1,295
Sacramento	1	10	31	91,554	91,585	3,205,475
San Bernardino	28	1	952	2	954	33,390
San Joaquin and Stanislaus [3]	--	3	------	6,090	6,090	213,150
San Mateo	--	[5]	------	4	4	140
Shasta	10	3	911	2,467	3,378	118,230
Sierra	9	10	17,449	196	17,645	617,575
Siskiyou	4	7	93	4,008	4,101	143,535
Trinity	3	15	38	7,733	7,771	271,985
Tuolumne	10	1	276	38	314	10,990
Yuba	[4]	6	[4]	48,746	[4] 48,746	[4] 1,706,110
Total: 1951	173	121	152,108	187,624	339,732	$11,890,620

[1] Excludes itinerant prospectors, snipers, high-graders, and others who gave no evidence of legal right to property.
[2] Fresno County placer gold included with Mariposa County.
[3] Combined to avoid disclosure of individual output.
[4] Yuba County lode gold included with Nevada County.
[5] From property not classed as a mine.

FIGURE 7. Placer miner at work recovering gold, Amador County. *Photo by Mary R. Hill.*

The following quotation from Maurer * gives an outline of gold mining activities in 1951.

"The closing down of several dredges attributed both to operating difficulties and depletion of values at some gravel deposits, coupled with the almost insurmountable economic barrier to expansion at precious-metal lode mines imposed by fixed prices for gold and silver, had adverse effect on the California gold industry during 1951. Placer mines furnished about 56 percent of the State's total gold compared to 60 percent in 1950, and the principal producers of placer gold were: Yuba Consolidated Gold Fields which operated dredges in the Yuba River district, Yuba County, the Oroville district, Butte County and the Scott River district, Siskiyou County; and the Natomas Co. dredges and Capital Dredging Co. boats in Folsom district, Sacramento County. Dredges of the Snelling Gold Dredging Co., Merced River district, Merced County and Fairview Placers, Trinity River district, Trinity County, also contributed to the State's total placer gold.

"New placer mining enterprises in 1951 include: The Alcan Mining Co. bucket-line dredge on Coffee Creek and the Oregon Gulch Gold Dredging Co. bucket-line dredge at the La Grange property, both in Trinity County; Thurman and Wright dragline dredge, Butte Creek district, Butte County (which was moved from Mariposa County); the Mountain Gold Dredging Co. dragline, Campo Seco (Spring Valley) district, Calaveras County (moved from Sacramento County), and the Minona Mining Co. development, French Corral district, Nevada County. Among dredges that either terminated or suspended operations during the year were those of Yuba Consolidated Gold Fields, Siskiyou unit, Scott River district; the Cosumnes Dredging Co., Cosumnes River district, and General Dredging Co., Folsom district, Sacramento County; Gold Hill Dredging Co., Camanche district, San Joaquin County; La Grange Gold Dredging Co., Tuolumne River district, Stanislaus County; Thurman Gold Dredging Co., Redding district, Shasta County, and River Pine Dredging Co., Mother Lode district, El Dorado County.

"Idaho Maryland Mines Corp. and Empire Star Mines, Ltd., Grass Valley-Nevada City district, Nevada County; Central Eureka Mining Co., Mother Lode district, Amador County; Original Sixteen-to-One Mine, Inc., Alleghany district and Best Mines Co., Downieville district, Sierra County, and Burton Bros., Inc., Mojave district, Kern County, were leading lode gold producers in 1951. Those smaller operations with more consistent output during the year included the Hazel Creek Mining Co., East Belt district, El Dorado County, and Blackstone Mine, East Belt district, Calaveras County."

Gold production by counties is shown in the table on page 70.

Gypsum. The 1951 California gypsum output was the largest in both quantity and value so far reported in the state. The crude gypsum produced from California deposits totaled 1,092,883 short tons valued at $2,602,785, as compared with 962,373 short tons worth $2,462,604 for 1950. The 1951 production came from four properties in Kern County; two properties in Fresno County; and one property each in Imperial, Kings, Riverside, and Ventura Counties. In addition to the above, but not included in the state total, was a considerable quantity of synthetic gypsum produced as a by-product in the reduction of magnesia from sea water at a plant in Alameda County.

Gypsum sold to California agriculturalists as a soil conditioner in 1951 totaled 611,024 short tons, compared with 327,970 short tons in 1950.

Iron Ore. The iron ore production in California during 1951 was the largest on record and totaled 1,198,847 gross tons, as compared with 831,445 gross tons in 1950. Shipments of iron ore from properties in Riverside and San Bernardino Counties in 1951 totaled 1,182,799 gross tons as compared with 849,489 tons for 1950.

* Maurer, R. B., Gold, silver, lead and zinc production in California in 1951: U. S. Bur. Mines, Annual Area Rept. C-4, January 14, 1951.

Principal production was from the Eagle Mountain mine in Riverside County which shipped to the Fontana steel mill of the Kaiser Company. A small production and shipment was reported from the Bessemer mine in San Bernardino County.

Iodine. California is the only state in which iodine is recovered. Two companies produced iodine in California during 1951, from oil-well waters at the Dominguez, Long Beach, Inglewood, and Seal Beach oil fields, all located in Los Angeles County.

Lead. The value of lead production in California during 1951 was at an all-time high, although the quantity produced fell below the peak established in the previous year. The recoverable lead reported mined and shipped from California mines totaled 27,934,000 pounds worth $4,832,582, as compared with 31,662,000 pounds worth $4,274,370 for 1950.

The principal production was made in Inyo County at the Darwin and Shoshone mines of the Anaconda Copper Mining Co. The lead-oxide section of the Darwin mill was placed in operation in September 1951. Other substantial producers were: the Afterthought mine in Shasta County, the Penn mine in Calaveras County, and the Minnietta and Lippincott mines in Inyo County. Numerous small mines and tailings dumps in Inyo County were intermittent producers.

The following table presents the California lead production in 1951, by counties.

Mine production of lead in California, 1951, by counties.

County	Pounds	Value
Calaveras	89,100	$15,414
El Dorado	13,300	2,301
Inyo	26,079,500	4,511,754
Kern	2,500	432
Mariposa	600	104
Riverside	51,100	8,840
San Bernardino	309,700	53,578
Shasta	1,388,200	240,159
Total	27,934,000	$4,832,582

Lime. The lime manufactured in California during 1951 totaled 203,344 short tons valued at $3,366,959, as compared with 171,440 short tons worth $2,722,835 in 1950. The 1951 lime output came from two properties in El Dorado and two properties in San Bernardino, and one property each in Monterey and Tuolumne Counties.

During 1951 California agriculture used 7,297 short tons of by-product lime and 2,132 short tons of hydrated lime as soil conditioners.

Limestone (see Stone).

Lithium Minerals. The brines of Searles Lake, San Bernardino County, are the chief source of the nation's lithium. Lithium-sodium phosphate was produced in 1950 and 1951.

Magnesite. The magnesite mined and shipped in California during 1950 and 1951 consisted of a small tonnage of hand-sorted ore, and a lesser amount of flotation concentrates produced from a property at Red Mountain, in Santa Clara County.

Magnesium Compounds (From Sea Water and Bitterns). Magnesia (magnesium oxide) was produced during 1951 in California from sea water, bitterns, and dolomite. The three producing plants were in Alameda, Monterey, and San Mateo Counties. The plant in San Mateo County also produced magnesium carbonate and hydroxide. The magnesium salts from this plant were all U.S.P. or technical grade, and were used in pharmaceuticals. The material from Alameda and Monterey Counties was used in refractories, oxychloride cements, rayon, insulation, epsom salt, and for other purposes. Magnesium chloride was recovered in a plant at Chula Vista, San Diego County.

Insulation manufacturers in Alameda and San Mateo Counties purchased magnesium oxide from the primary producers and converted it into magnesium carbonate for pipe coverings.

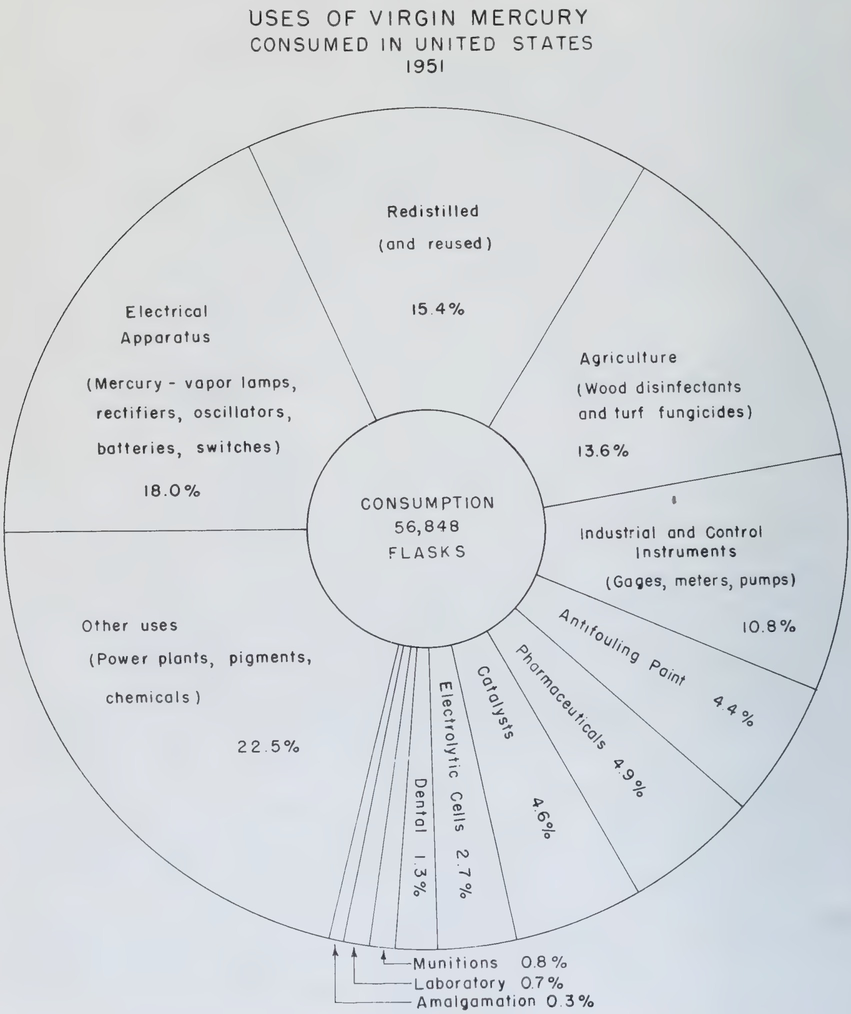

FIGURE 8.

Magnesium Metal. Magnesium metal was made at the Kaiser Magnesium Company plant at Manteca in 1951 by the Pigeon ferro-silicon process. This was the first magnesium metal reduced in the state since 1946.

Manganese Ore. During 1951 no manganese ore was reported shipped from California sources. In 1950 shipments of manganese ore from California mines totaled 677 tons worth $7,295, containing 139 tons of manganese.

Mercury (Quicksilver). California was the leading mercury producing state, its contribution to the national total constituting 59 percent. The production of mercury (quicksilver) in California during 1951 totaled 4,282 flasks of 76 pounds valued at $899,777, as compared with 3,850 flasks worth $313,000 in 1950. The 1951 output came from nine properties in San Benito County; five properties in Sonoma County; three each in Napa and Santa Clara Counties; two in Lake County; and one property each in Contra Costa, Del Norte, Fresno, San Luis Obispo, and Yolo Counties.

The Mt. Jackson mine in Sonoma County was the largest mercury producer in the United States. The New Idria mine, San Benito County, was reactivated about the middle of the year. This mine was the largest mercury producer in the country during World War II. The Dewey-Buckman mine near The Geysers, Sonoma County, was prepared for large scale operation.

FIGURE 9. New Idria quicksilver mine plant. This mine in San Benito County was reactivated in 1951 to provide mercury for national defense.

Mineral Pigments. Mineral pigments manufactured in California during 1951 came from plants in Alameda and Amador Counties. The former produced iron-colored pigments, and the latter produced a van dyke brown made from coal.

FIGURE 10. Diamond drilling at New Almaden quicksilver district, Santa Clara County. *Photo by Charles W. Jennings.*

Mineral Water. Water from many springs and artesian wells, bottled and in part artificially carbonated, is classed as mineral water. Health and pleasure resorts are located at many hot springs in California. The water at some of the hot springs is not suitable for drinking, but is utilized for bathing. Counties from which mineral waters are bottled and sold are: Butte, Calaveras, Contra Costa, Lake, Los Angeles, Marin, Napa, Orange, Riverside, San Benito, San Bernardino, San Diego, San Francisco, San Luis Obispo, Santa Barbara, Shasta, Siskiyou, Sonoma, and Tehama. No canvass of mineral water producers is made by the U. S. Bureau of Mines.

Molybdenum. Molybdenum concentrates were produced in California as a by-product of tungsten recovery. The 1950 and 1951 output came

from the Pine Creek mine of the U. S. Vanadium Corporation near Bishop, Inyo County.

Natural Gas. The value of reported natural gas coming from California sources in 1951 was the largest of any year on record, although the quantity was slightly less than in 1948. In 1951 production was reported from wells in 22 counties and totaled 566,751,000 thousand cubic feet worth $82,745,000, as compared with an output from wells in 21 counties totaling 558,398,000 thousand cubic feet worth $66,944,000 in 1950. The following table gives the 1951 natural gas production in California by counties:

County	M cu. ft.	Value
Fresno	56,575,373	$7,963,025
Glenn	1,145,583	194,749
Humboldt	1,508,160	271,469
Kern	76,540,276	10,120,538
Kings	29,676,314	5,053,572
Los Angeles	115,969,311	15,334,043
Madera	2,934,141	536,948
Orange	31,685,262	4,443,497
Sacramento	77,706,733	14,608,866
San Joaquin	5,465,038	1,027,427
San Luis Obispo	1,308,512	131,074
Santa Barbara	29,289,351	3,197,980
Solano	52,237,400	9,831,079
Tulare	4,876,910	872,967
Ventura	74,029,894	8,157,165
Yolo	2,935,080	498,964
Butte, Contra Costa, Monterey, San Bernardino, Stanislaus, Sutter	2,867,662	501,637
Totals	566,751,000	$82,745,000

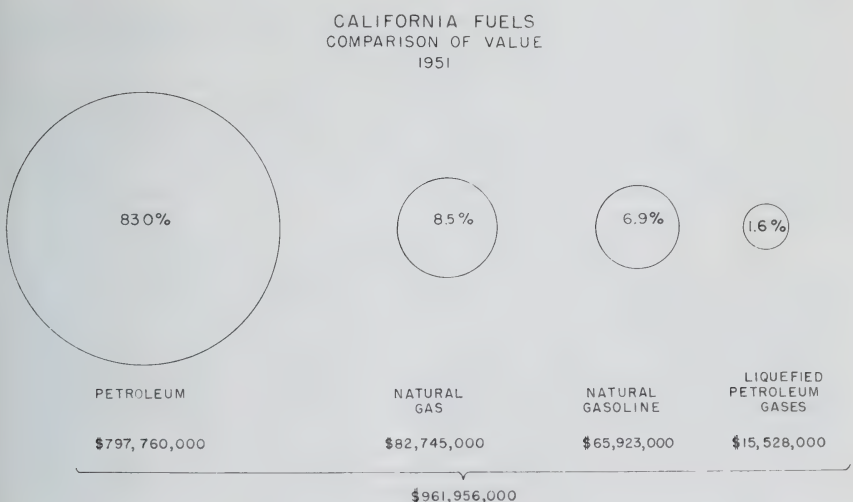

FIGURE 11.

CALIFORNIA
NATURAL GAS PRODUCTION
BY COUNTIES
1951

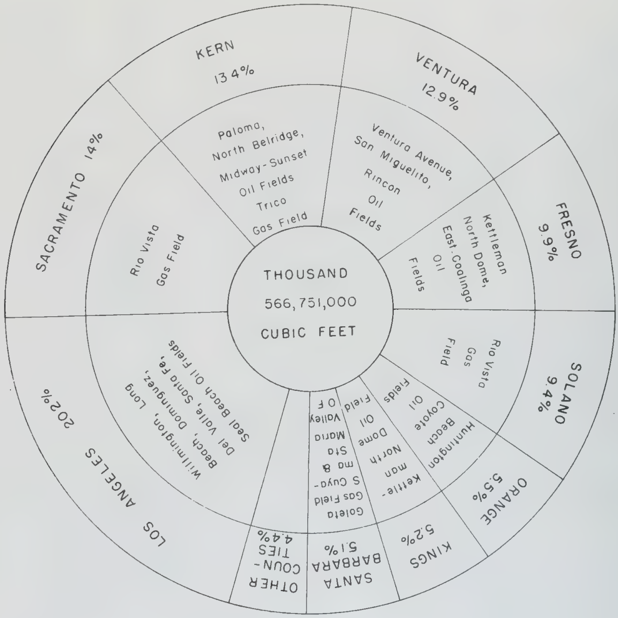

FIGURE 12.

Natural Gas Liquids. Natural gas liquids were recovered at 74 plants located near the oil fields in California during 1951. Liquefied petroleum gases were recovered at 38 of these plants.

Natural gasoline and cycle products produced in California during 1951 totaled 21,131,950 barrels valued at $65,923,000, as compared with 21,246,677 barrels worth $65,527,000 in 1950.

Liquefied petroleum gases produced in California during 1951 totaled 8,400,774 barrels valued at $15,528,000, as compared with 7,081,484 barrels worth $14,497,000 in 1950.

The following table gives the 1951 output of natural gas liquids for 1951:

County	Number of plants	Natural gasoline: Barrels	Natural gasoline: Value	Liquefied petroleum gases: Barrels	Liquefied petroleum gases: Value
Fresno	6	1,581,864	$5,266,000	1,518,548	$2,920,000
Kern	16	6,013,368	18,962,000	3,262,766	6,404,000
Kings and San Luis Obispo	3	1,084,427	3,408,000	853,077	1,636,000
Los Angeles	26	6,314,214	19,782,000	706,463	1,274,000
Orange	8	2,803,356	8,889,000	283,121	434,000
Santa Barbara	7	730,819	2,279,000	594,306	880,000
Ventura	8	2,603,902	7,337,000	1,182,493	1,980,000
Totals	74	21,131,950	$65,923,000	8,400,774	$15,528,000

Peat. Peat gathered from bogs in Modoc, Contra Costa, and Orange Counties during 1951 totaled 6,432 short tons worth $42,016, as compared with 6,399 short tons worth $37,192 in 1950.

Perlite. Crude perlite was produced in California during 1951 from properties in Inyo, Napa, and San Bernardino Counties. Eleven perlite expanding plants operating in Contra Costa, Los Angeles, Marin, Napa, and San Bernardino Counties during 1951 produced 25,850 short tons of expanded perlite and sold or used 25,648 short tons worth $1,481,428. California plants reported production of 12,179 short tons of expanded perlite worth $648,879 in 1950.

Petroleum. California ranked second among the states of the nation in petroleum output for 1951. Crude oil led all other mineral substances in value of output and in 1951 accounted for approximately 66 percent of the state's total value of minerals products. During 1951 California oil wells produced 354,516,000 barrels of petroleum valued $797,760,000, compared with 327,607,000 barrels worth $707,630,000 in 1950.

The following table gives the 1950 and 1951 petroleum output by counties:

	1950		1951	
County	Barrels	Value	Barrels	Value
Fresno	41,265,000	$99,778,000	41,161,491	$99,282,709
Kern	84,017,000	159,126,000	89,651,073	191,572,128
Kings	4,356,000	11,235,000	3,755,435	10,349,585
Los Angeles	96,870,000	210,898,000	99,237,746	229,431,437
Monterey	*	*	2,746,916	2,973,108
Orange	33,918,000	65,048,000	38,346,863	82,140,228
San Luis Obispo	3,503,000	9,003,000	3,741,575	9,480,379
Santa Barbara	29,592,000	59,784,000	38,652,268	80,757,134
Ventura	33,889,000	92,550,000	37,185,979	91,693,553
Other counties [a]	197,000	208,000	36,654	79,739
Totals	327,607,000	$707,630,000	354,516,000	$797,760,000

* Included with other counties.
[a] Includes San Benito, San Bernardino, Santa Clara, Sonoma, and Tulare.

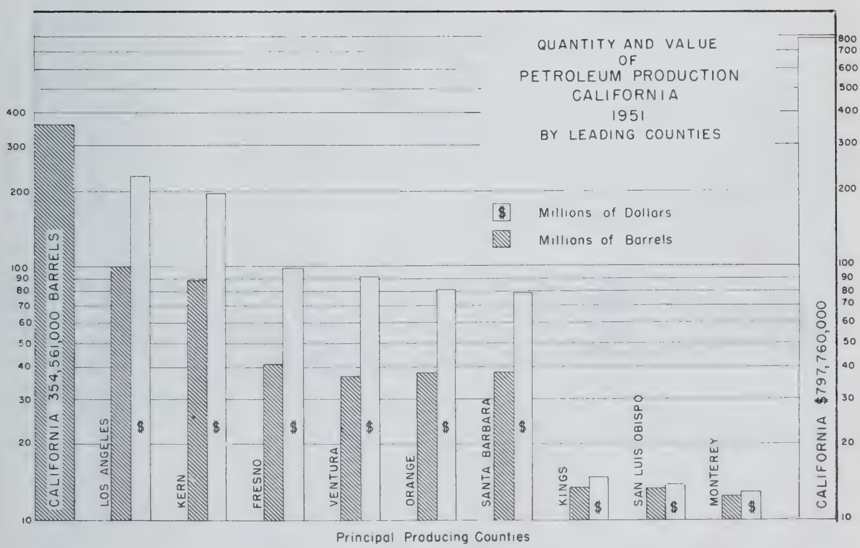

FIGURE 13.

FIGURE 14. Kettleman Hills North Dome oil field, Kern County. *Photo by Charles W. Jennings.*

The production of crude petroleum in California was the largest of any year on record, according to E. T. Knudsen, in an article entitled *The petroleum situation in District 5* issued by the U.S. Bureau of Mines in February 1952. The estimate of production and utilization of California petroleum during 1951 is shown in the accompanying table.

	Barrels of 42 gal., 1951	Stocks on hand Dec. 31, 1951, barrels of 42 gal.
Crude petroleum	354,467,000	------
Condensates	2,449,000	------
Natural gasoline	18,612,000	------
Liquefied petroleum gases	8,501,000	------
Refinery input and transfers		
Crude petroleum to refinery	349,130,000	29,723,000
Crude petroleum transferred to fuel	1,915,000	------
Condensate	1,997,000	28,000
Natural gas gasoline	18,807,000	858,000
Liquefied petroleum gases	7,638,000	332,000
Total refinery input	379,487,000	
Refinery production and transfers		
Gasoline and naphtha distillates	150,904,000	17,416,000
Kerosene and kerosene distillates	3,131,000	695,000
Lubricating oils, greases, and distillates	4,925,000	2,559,000
Stove oils and diesel oil	50,725,000	8,909,000
Fuel oil	134,196,000	13,357,000
Asphalt and road oil	12,881,000	1,262,000
Coke and other finished products	------	770,000
Unfinished stock	------	8,290,000
Total stock as of Dec. 31, 1951		84,199,000

Platinum. The crude platinum reported from California during 1951 totaled 308 fine ounces worth $38,200 and came from placer properties (mostly dredges) in Amador, Mariposa, Sacramento, San Joaquin, and Shasta Counties.

Potash. Potassium salts were produced in California during 1950 and 1951 from the brines of Searles Lake, San Bernardino County, by the America Potash and Chemical Company.

Pumice and Pumicite. Pumice and pumicite (volcanic ash) produced and shipped in California during 1951 totaled 264,411 short tons valued at $1,228,569. This was an all-time high in both quantity and value of production. Production was reported from seven properties in Siskiyou County; three properties each in Calaveras, Inyo, and Mono Counties; two properties each in Madera and San Bernardino Counties; and one property each in Imperial, Modoc, and Napa Counties. The 1951 output of pumice and pumicite showed an increase in both quantity and value over the 1950 production which was 157,409 short tons worth $970,826.

Pyrite. Pyrite produced in California during 1951 came from the Hornet mine at Matheson, Shasta County. This mine has been the chief source of the state's pyrite output for many years.

Quicksilver (see Mercury).

Salt. The 1951 salt yield in California was the largest in both quantity and value so far recorded. The 1951 shipments totaled 1,275,574 short tons valued at $5,261,780, as compared with 868,496 short tons

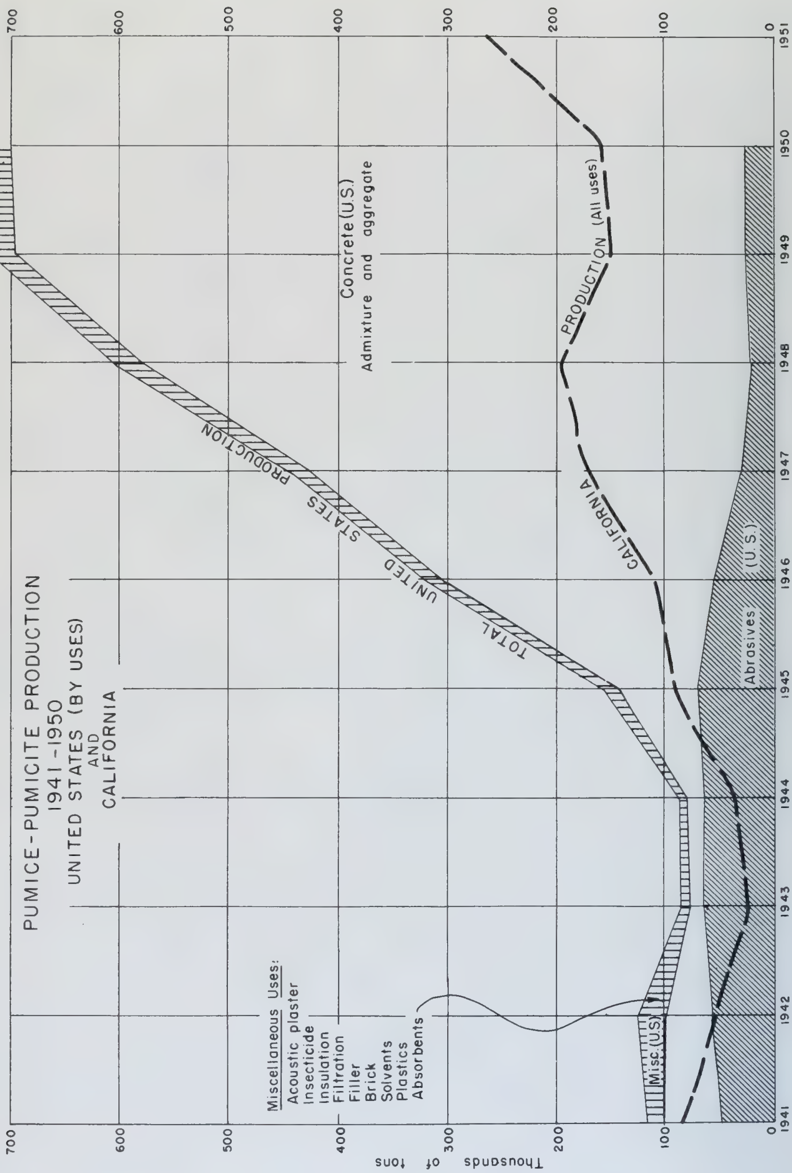
PUMICE-PUMICITE PRODUCTION
1941-1950
UNITED STATES (BY USES)
AND
CALIFORNIA
Miscellaneous Uses:
Acoustic plaster
Insecticide
Insulation
Filtration
Filler
Brick
Solvents
Plastics
Absorbents
Misc. (U.S.)
Concrete (U.S.)
Admixture and aggregate
TOTAL UNITED STATES PRODUCTION
CALIFORNIA PRODUCTION (All uses)
Abrasives (U.S.)
Thousands of tons
0
100
200
300
400
500
600
700
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951

FIGURE 15.

FIGURE 16. Salt harvesting operation, Kern County. *Photo by W. E. Ver Planck.*

worth $3,816,655. The 1950 and 1951 shipments were made by four companies in Alameda County; two properties in San Bernardino County; and one property each in Monterey, Orange, and San Diego Counties.

Sand and Gravel. California has led the states of the nation in the output of sand and gravel for several years. In 1950 production was approximately 12 percent of the national total. The 1951 output of sand and gravel was the largest annual yield so far reported in the state and totaled 46,927,640 short tons valued at $41,280,000, as compared with 41,894,039 short tons worth $35,547,558 in 1950. Fifty-five of the fifty-eight counties in the state (95 percent) contributed to the production of this commodity.

The following table gives the 1951 sand and gravel output by counties:

County	Short tons	Value
Alameda	6,285,055	$6,490,890
Butte	321,355	442,489
Colusa	259,576	158,486
Contra Costa	183,578	159,819
Del Norte	163,399	172,357
El Dorado	88,901	128,513
Fresno	674,424	505,820
Humboldt	1,248,803	744,539
Inyo	25,632	10,006
Kern	839,239	944,882
Los Angeles	15,820,669	11,012,775
Madera	17,569	19,102
Mendocino	161,370	242,217
Merced	525,415	366,514
Modoc	255,417	60,367
Monterey	878,022	1,543,582
Napa	27,118	35,375
Orange	1,495,895	1,112,322
Plumas	46,552	27,308
Riverside	1,266,103	1,348,058
Sacramento	3,577,191	4,012,848
San Benito	280,080	164,946
San Bernardino	1,084,097	1,048,119
San Diego	1,788,145	2,501,378
San Joaquin	1,866,075	1,695,331
San Luis Obispo	158,042	84,751
Santa Clara	550,013	570,054
Shasta	381,485	306,225
Sierra	2,687	11,800
Stanislaus	505,312	431,185
Sutter	83,880	43,790
Tulare	432,209	466,314
Ventura	1,189,330	864,487
Yolo	366,345	245,701
Yuba	227,367	232,365
Alpine, Amador, Calaveras, Glenn, Imperial, Kings, Lake, Lassen, Marin, Mariposa, Mono, Placer, San Mateo, Santa Barbara, Santa Cruz, Siskiyou, Sonoma, Tehama, Trinity, Tuolumne	2,906,800	2,429,277
Totals segregated by counties	45,984,150	$40,633,992
Reported from California but not segregated by counties	943,490	646,008
Totals	46,927,640	$41,280,000

FIGURE 17. Sand treatment plant at Pacific Grove, Monterey County. Beach sand is processed for glass-making by the Owens-Illinois Glass Co.

Silver. The silver output in California during 1951 totaled 1,145,219 fine ounces worth $1,036,481, as compared with 1,071,917 fine ounces worth $970,139 in 1950. In 1951 the lode mines produced 1,132,757 fine ounces and the placers produced only 12,462 fine ounces.

The following was taken from Maurer * in preliminary report of the U.S. Bureau of Mines, on gold, silver, copper, lead, and zinc production in California in 1951.

"Closely associated with the output of base-metal ores, 1951 silver, other than that recovered incidental to gold at precious-metal mines, largely was from the Anaconda Copper Mining Co. Darwin and Shoshone properties, respectively in the Coso district and Resting Springs district, Inyo County (lead and zinc-lead ores); the Coronado Copper & Zinc Co. Afterthought mine, Cow Creek (Ingot) district, Shasta County (zinc ore), and the Penn Chemical Co. Penn mine, Campo Seco district, Calaveras County (zinc ore)."

The following table gives the 1951 silver output in California by counties:

Mine production of silver in California, 1951, by counties, in terms of recoverable metal.

	Fine ounces		Total	
County	Lode	Placer	Fine ounces	Value
Alpine	1	---	1	$1
Amador	3,649	32	3,681	3,331
Butte	31	1,037	1,068	967
Calaveras	39,988	87	40,075	36,270
El Dorado	1,047	53	1,100	996
Fresno	---	1	1	1
Humboldt	---	---	---	---
Imperial	204	---	204	185
Inyo	856,232	---	856,232	774,933
Kern	33,200	75	33,275	30,116

* Maurer, R. B., Gold, silver, lead and zinc production in California in 1951: U. S. Bur. Mines, Annual Area Rept. C-4, Jan. 14, 1951.

Mine production of silver in California, 1951, by counties, in terms of recoverable metal.—Continued

County	Fine ounces		Total	
	Lode	Placer	Fine ounces	Value
Los Angeles	168	9	177	160
Madera	8	164	172	155
Mariposa	68	[1] 787	[1] 855	[1] 774
Merced	---	511	511	462
Modoc and Mono	[2] 1,388	---	1,388	1,256
Nevada	[3] 31,098	182	[3] 31,280	[3] 28,310
Placer	500	43	543	492
Plumas	4	11	15	14
Riverside	1,207	---	1,207	1,092
Sacramento	6	4,070	4,076	3,689
San Bernardino	12,081	---	12,081	10,934
San Joaquin and Stanislaus	[2]	581	581	526
San Mateo	---	1	1	1
Shasta	148,253	290	148,543	134,439
Sierra	3,470	13	3,483	3,152
Siskiyou	27	479	506	458
Trinity	18	809	827	748
Tulare	37	---	37	34
Tuolumne	72	9	81	73
Yuba	[3]	3,219	[3] 3,219	[3] 2,913
Total: 1951	1,132,757	12,462	1,145,219	$1,036,481

[1] Fresno County silver included with Mariposa County.
[2] Combined to avoid disclosure of individual output.
[3] Yuba County silver included with Nevada County.

Silica (Quartz and Sand). Quartz was mined at single properties in Kern, Mariposa, and San Bernardino Counties; and silica sand was produced from a property in Monterey County during 1951. The total output of 79,276 short tons was worth $507,265.

Silica sand used in the manufacture of glass and ceramics was mined in Monterey and Riverside Counties but the production figures are included under ''sand and gravel,'' not silica.

Slate. The slate mined in California during 1951 came from properties in El Dorado and Mariposa Counties. The production from El Dorado County was used for roofing granules and slate flour. The Mariposa County production was used as flagstone.

Soda and Saltcake. The value of sodium carbonate production during 1951 in California was the largest thus far reported, although the quantity of production fell below the record output reported in 1950. The sodium carbonate (soda ash and trona) produced in California during 1950 and 1951 came from properties of three companies operating on Owens Lake in Inyo County, and from properties of two companies on Searles Lake in San Bernardino County.

The 1951 output of saltcake was the largest on record. The saltcake production in California for 1950 and 1951 came from a property on Searles Lake, San Bernardino County.

Stone (Miscellaneous). The granite quarried in California during 1951 for monumental and building stone totaled 38,184 cubic feet (8,719 short tons) worth $340,231 and came from seven properties in San Diego County, and one property each in Fresno, Lassen, Los Angeles,

FIGURE 18. Quarry and stock-piles, Passadori Carmelstone quarry, Monterey County. *Photo by Mary R. Hill.*

Placer and San Bernardino Counties; compared with 77,650 cubic feet (17,770 short tons) worth $259,447 in 1950 coming from seven properties in San Diego County, and single properties in Fresno, Lassen, Los Angeles, Mariposa, Mono, Placer, and San Bernardino Counties. The granite coming from Fresno, Lassen, Placer, and San Diego Counties was chiefly used as monumental stone.

The limestone and dolomite quarried in California during 1951 totaled 1,167,434 short tons valued at $3,614,491 as compared with 1,065,439 short tons worth $2,899,767 in 1950. The 1951 output of limestone came from five properties in San Bernardino County, four properties in El Dorado County, two properties each in Santa Cruz and Tuolumne Counties; and single properties in Monterey, Riverside, San Benito, San Mateo, Santa Clara, and Ventura Counties.

Most of the limestone quarried in El Dorado, Riverside, San Bernardino, Santa Cruz, Tuolumne and Ventura Counties and part quarried from Santa Clara County was high grade limestone and was used as a flux in metallurgical processes; in the manufacturing processes for sugar, soda ash, paints, rubber, glass, chemicals; in agriculture; in chicken grit and poultry feed; as a filler, as granules for roofing and terrazzo; and other special uses. The material from Monterey and San Benito Counties, and part of the production from Tuolumne County was dolomite which was used in refractories, and as a chemical agent in the reduction of magnesia from sea water. The material produced from the other counties was used as crushed rock in concrete and as fill rock.

During 1951 a total of 11,375,342 short tons of crushed stone, rubble, fill rock and flagstone worth $10,782,572 was quarried in California, as compared with 10,681,421 short tons worth $10,839,218 in 1950. The following table gives the 1951 output of miscellaneous stone by counties:

County	Tons	Value
Alameda	1,129,135	$1,154,076
Contra Costa	574,296	675,584
Fresno	247,514	282,701
Kern	102,874	104,566
Los Angeles	3,417,258	2,278,376
Monterey	79,050	87,914
Orange	201,198	200,717
San Diego	242.054	378,223
San Luis Obispo	42,490	46,739
San Mateo	735,636	671,000
Shasta	184,474	150,620
Siskiyou	195,876	129,124
Solano	211,212	226,173
Sonoma	90,123	121,588
Amador, Butte, Calaveras, El Dorado, Humboldt, Lassen, Madera, Marin, Mariposa, Merced, Mono, Napa, Placer, Riverside, Sacramento, San Benito, San Bernardino, San Joaquin, Santa Barbara, Stanislaus, Trinity, Tulare, Tuolumne, Ventura	3,880,369	4,117,033
Not segregated by counties	41,783	$158,138
Totals	11,375,342	$10,782.572

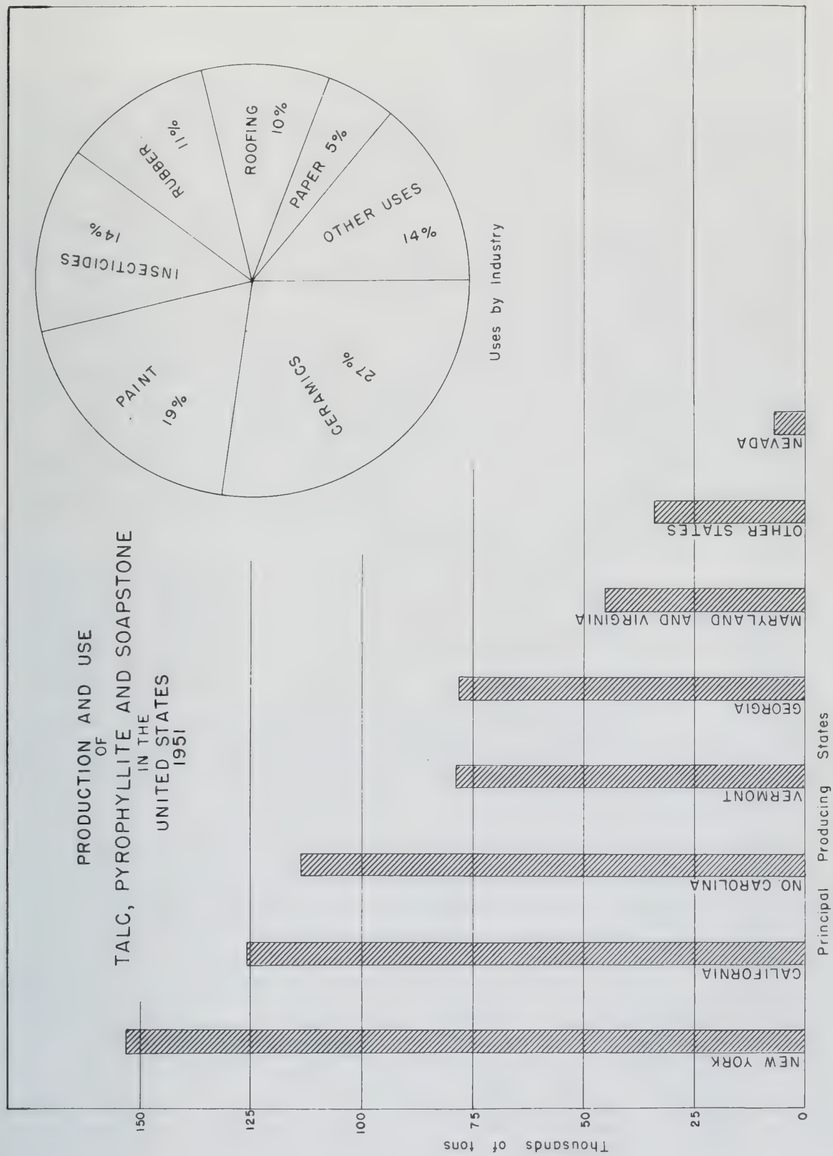

FIGURE 19. Chart showing principal talc-producing states, 1951, and industrial uses.

Sulfur. A small amount of native sulfur was mined and shipped from a single property in Inyo County during 1950 and 1951. During 1951 stripping was under way in preparation to mining sulfur at the Leviathan mine in Alpine County. The sulfur will be used in the manufacture of sulfuric acid with the ultimate purpose of leaching low-grade copper ores from Nevada.

In addition to the native sulfur a much larger tonnage of by-product sulfur was recovered from sour petroleum refinery gases at a plant at Watson, Los Angeles County. Hydrogen sulfide was recovered at oil refineries at Richmond, Contra Costa County; and at Dominguez, El Segundo, and Watson in Los Angeles County.

Talc, Soapstone, and Pyrophyllite. The talc, pyrophyllite and soapstone produced from California properties during 1951 totaled 126,784 short tons worth $2,269,771, compared with 109,747 short tons worth $2,069,211 in 1950. The 1951 output came from properties in El Dorado, Inyo, Los Angeles, Mono, and San Bernardino Counties. The material from Inyo County and part of the material from San Bernardino County was high grade talc; the production from Mono County and part of the production from San Bernardino County was pyrophyllite; the production from El Dorado and Los Angeles Counties was soapstone.

The following table gives the 1951 talc, pyrophyllite, and soapstone production in California by counties:

County	Short tons	Value
Inyo	50,817	$756,637
San Bernardino	60,019	1,332,522
El Dorado, Los Angeles, Mono	15,948	180,612
Totals	126,784	$2,269,771

Titanium. A small tonnage of ilmenite concentrates was reported from Hermosa Beach in Los Angeles County during 1951. The 1950 output of ilmenite sands came from a property in Sand Canyon near Saugus, Los Angeles County.

Tungsten. California led all states in output of tungsten concentrates, with approximately 48 percent of the national shipments in 1951. High grade tungsten concentrates produced in California during the year totaled 2,490 short tons containing 149,694 units of WO_3. Shipments over the same period totaled 3,007 short tons containing over 180,000 units of WO_3 and were valued at $11,557,325, an all-time high. The 1950 production of tungsten concentrates in California totaled 1,686 short tons or 101,200 units of WO_3, and shipments for 1950 were 2,025 short tons or 121,492 units of WO_3, valued at $3,392,000.

The principal ore production was made at the Pine Creek mine, Inyo County. Other leading counties in the production of ore and concentrates were: San Bernardino, Madera, Tulare, Fresno, Alpine, and Kern.

Zinc. The value of zinc produced in California during 1951 was at an all-time high, although the quantity of production has been exceeded in two previous years. Mine production of recoverable zinc in California during 1951 totaled 19,204,000 pounds worth $3,495,128 as compared with 15,102,000 pounds worth $2,144,484 for 1950.

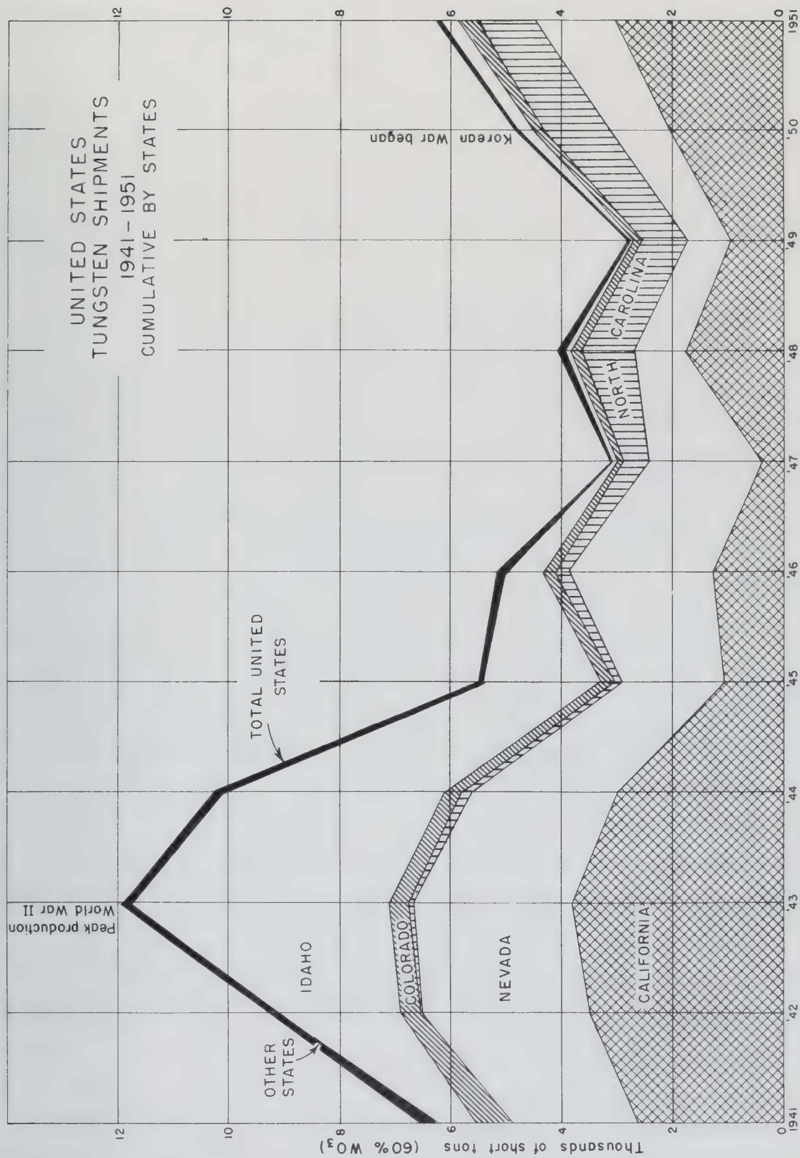

FIGURE 20. Chart showing tungsten shipments from principal producing states, 1941-51.

The principal producers were the Darwin and Shoshone mines in Inyo County, the Afterthought mine in Shasta County, and the Penn mine in Calaveras County. Some carbonate ore was produced at the Carbonate King mine in San Bernardino County.

The following table gives the 1951 zinc output in California by counties.

Mine production of zinc in California, 1951, by counties.

County	Pounds	Value
Calaveras	1,767,300	$321,648
Inyo	11,176,900	2,034,196
Kern	7,800	1,420
San Bernardino	132,400	24,097
Shasta	6,119,600	1,113,767
Totals	19,204,000	$3,495,128

MINERAL PRODUCTION IN THE COUNTIES OF CALIFORNIA

Seventy-four percent of the counties of California showed an increase in mineral production during 1951 over that of the previous year. Production was made in 57 of the 58 counties in the state; no production was reported from San Francisco County. About 34 percent of the counties reported an all-time high in value of mineral production. Included in this group of counties were: Alameda, Alpine, Calaveras, Humboldt, Inyo, Los Angeles, Marin, Monterey, Riverside, Sacramento, San Benito, San Bernardino, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Ventura, and Yolo.

Los Angeles headed the list of mineral producing counties for the second consecutive year. The six leading counties—Los Angeles, Kern, Fresno, Ventura, Orange, and Santa Barbara—were producers of petroleum products. Each of these counties with the exception of Fresno, reported an increase in valuation of mineral products over the previous year. San Bernardino County ranked seventh and showed the most diversified output with the production of 29 mineral commodities.

Excluding petroleum products the counties ranked as follows: San Bernardino (cement, salines); Kern (salines, cement); Santa Clara (cement); Inyo (lead and zinc); Riverside (cement, iron ore); Los Angeles (sand-gravel, diatomite); Alameda (sand-gravel, salt); Sacramento (sand-gravel, gold); Santa Barbara (diatomite, sand-gravel); San Mateo (cement, magnesium salts); Calaveras (cement, zinc); Santa Cruz (cement); San Benito (cement, stone, mercury); Nevada (gold and silver); San Diego (sand-gravel, dimension stone) and Shasta (zinc, pyrite).

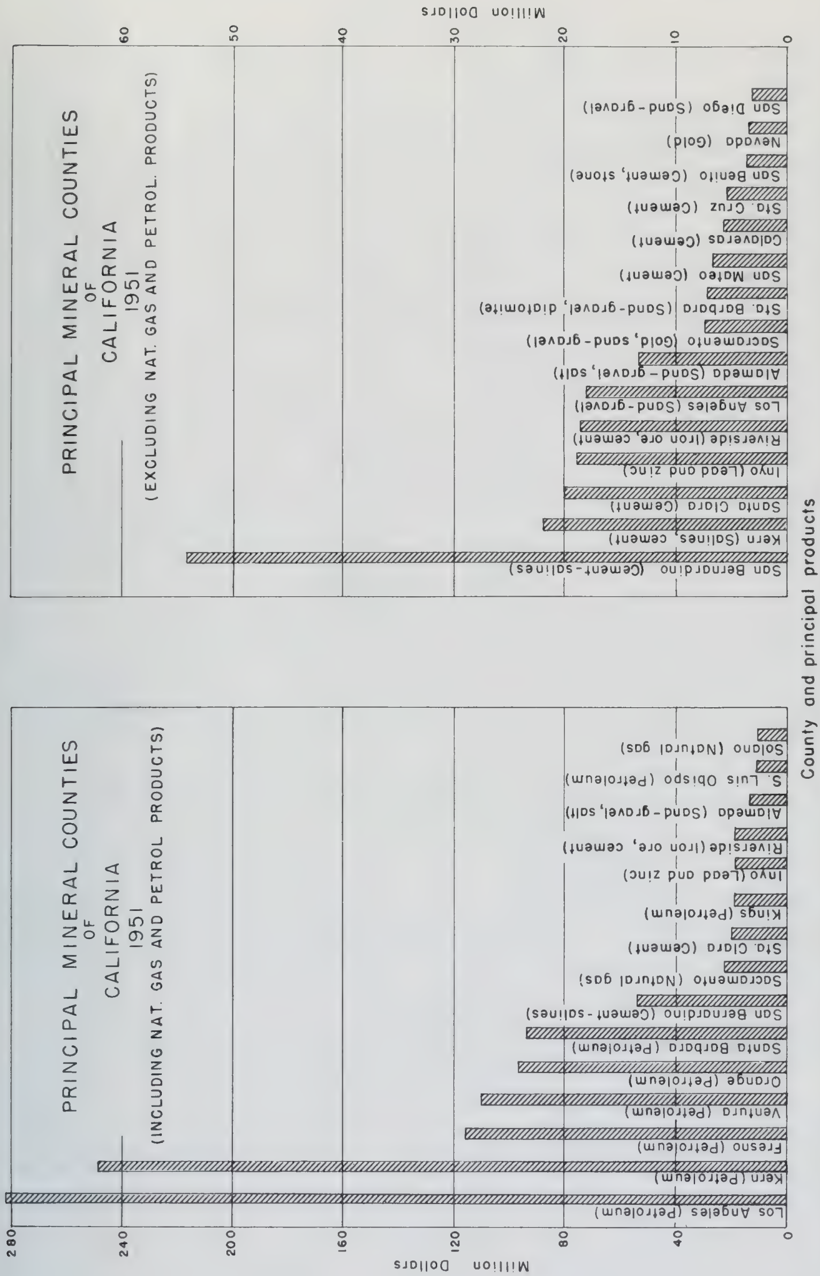

FIGURE 21. Chart showing principal mineral counties of California, 1951 (including and excluding natural gas and petroleum products).

Mineral production by counties in 1951, in order of value.

Rank	County	Value	Rank	County	Value
1	Los Angeles	$284,115,599	30	Butte	$1,354,164
2	Kern	249,449,434	31	Madera	1,240,273
3	Fresno	116,530,747	32	Amador	1,219,919
4	Ventura	110,437,071	33	Contra Costa	1,154,829
5	Orange	97,389,095	34	Humboldt	1,028,683
6	Santa Barbara	94,117,314	35	Tuolumne	1,020,937
7	San Bernardino	55,529,399	36	Marin	883,789
8	Sacramento	22,264,560	37	Yolo	744,875
9	Santa Clara	20,357,253	38	Stanislaus	709,411
10	Kings	19,634,393	39	Napa	666,653
11	Inyo	18,999,681	40	Sierra	632,551
12	Riverside	18,426,547	41	Merced	543,856
13	Alameda	13,296,033	42	Mono	534,757
14	San Luis Obispo	10,845,204	43	Siskiyou	526,738
15	Solano	10,057,252	44	Del Norte	502,714
16	Monterey	7,056,310	45	Placer	446,819
17	San Mateo	6,790,538	46	Trinity	308,644
18	Calaveras	5,725,493	47	Mariposa	286,644
19	Santa Cruz	5,650,959	48	Mendocino	253,417
20	San Benito	3,554,012	49	Modoc	244,850
21	Nevada	3,433,285	50	Sutter	212,294
22	San Diego	3,381,090	51	Glenn	201,649
23	Shasta	3,269,730	52	Colusa	158,486
24	San Joaquin	3,027,741	53	Lassen	112,577
25	El Dorado	2,030,731	54	Tehama and Lake	104,108
26	Yuba	1,941,388	55	Alpine	84,222
27	Tulare	1,654,670	56	Plumas	70,120
28	Imperial	1,637,612	57	Lake (see Tehama)	----
29	Sonoma	1,523,285	58	San Francisco	0

Undistributed $2,053,592

Total $1,209,428,000

Mineral Production in California in 1951 by Counties.

Alameda County

Product	Quantity	Value
Sand and gravel	6,285,055 short tons	$6,490,890
Crushed stone	1,129,135 short tons	1,154,076
Unapportioned: Bromine, clay, magnesium salts, salt		5,651,067
Total value		$13,296,033

Alpine County

Mineral production in Alpine County in 1951 consisted of sand and gravel, silver, and tungsten concentrates.

Amador County

Product	Quantity	Value
Clay	188,112 short tons	$614,223
Copper	14,700 pounds	3,557
Gold	15,697 troy ounces	549,395
Silver	3,681 troy ounces	3,331
Unapportioned: Coal, platinum, sand and gravel, stone		49,413
Total value		$1,219,919

Butte County

Product	Quantity	Value
Gold	14,153 troy ounces	$495,355
Silver	1,068 troy ounces	967
Sand and gravel	321,355 short tons	442,489
Unapportioned: Chromite, natural gas, stone		415,353
Total value		$1,354,164

Mineral Production in California in 1951 by Counties—Continued

Calaveras County

Product	*Quantity*	*Value*
Copper	487,400 pounds	$117,951
Gold	2,749 troy ounces	96,215
Lead	89,100 pounds	15,414
Silver	40,075 troy ounces	36,270
Stone	17,000 short tons	35,000
Zinc	1,767,300 pounds	321,648
Unapportioned: Cement, clay, pumice and pumicite, sand and gravel		5,102,995
Total value		$5,725,493

Colusa County

Mineral production in Colusa County in 1951 consisted of sand and gravel.

Contra Costa County

Sand and gravel	183,578 short tons	$159,819
Stone	574,296 short tons	675,584
Unapportioned: Clay, mercury, natural gas		319,426
Total value		$1,154,829

Del Norte County

Sand and gravel	163,399 short tons	$172,357
Unapportioned: Chromite, mercury		330,357
Total value		$502,714

El Dorado County

Copper	3,700 pounds	$895
Gold	3,778 troy ounces	132,230
Lead	13,300 pounds	2,301
Silver	1,100 troy ounces	996
Sand and gravel	88,901 short tons	128,513
Unapportioned: Limestone, lime, slate, stone, soapstone		1,765,796
Total value		$2,030,731

Fresno County

Natural gas	56,575,373 M cu. ft.	$7,963,025
Natural gasoline	1,581,864 barrels	5,266,000
Liquefied petroleum gases	1,518,548 barrels	2,920,000
Petroleum	41,161,491 barrels	99,282,709
Sand and gravel	674,424 short tons	505,820
Stone	247,514 short tons	282,701
Unapportioned: Chromite, clay, gold, granite, tungsten concentrates, gypsum, mercury, silver		310,492
Total value		$116,530,747

Glenn County

Mineral production in Glenn County in 1951 consisted of natural gas, and sand and gravel.

Humboldt County

Gold	6 troy ounces	$210
Natural gas	1,508,160 M cu. ft.	271,469
Sand and gravel	1,248,803 short tons	744,539
Unapportioned: Clay, stone		12,465
Total value		$1,028,683

Imperial County

Gold	794 troy ounces	$27,790
Silver	204 troy ounces	185
Unapportioned: Carbon dioxide, clay, gypsum, pumice, sand and gravel		1,609,637
Total value		$1,637,612

Mineral Production in California in 1951 by Counties—Continued

Inyo County

Product	*Quantity*	*Value*
Copper	346,400 pounds	$83,829
Gold	4,846 troy ounces	169,610
Lead	26,079,500 pounds	4,511,754
Silver	856,232 troy ounces	774,933
Sand and gravel	25,632 short tons	10,006
Talc and pyrophyllite	50,817 short tons	756,637
Zinc	11,176,900 pounds	2,034,196
Unapportioned: Borates, clay (bentonite), fuller's earth, diatomite, molybdenum, perlite, pumice and pumicite, soda ash and trona, sulfur, tungsten concentrates		10,658,716
Total value		$18,999,681

Kern County

Clay	96,280 short tons	$700,620
Copper	300 pounds	73
Gold	9,042 troy ounces	316,470
Gypsum	287,813 short tons	454,750
Lead	2,500 pounds	432
Natural gas	76,540,276 M cu. ft.	10,120,538
Natural gasoline	6,013,368 barrels	18,962,000
Liquefied petroleum gases	3,262,766 barrels	6,404,000
Petroleum	89,651,073 barrels	191,572,128
Silver	33,275 troy ounces	30,116
Sand and gravel	839,239 short tons	944,882
Stone	102,874 short tons	104,566
Zinc	7,800 pounds	1,420
Unapportioned: Borates, cement, fuller's earth, pumicite, quartz, tungsten concentrates		19,837,439
Total value		$249,449,434

Kings County

Natural gas	29,676,314 M cu. ft.	$5,053,572
Natural gasoline	895,368 barrels	2,789,000
Liquefied petroleum gases	591,685 barrels	1,154,000
Petroleum	3,755,435 barrels	10,349,585
Unapportioned: Gypsum, sand and gravel		288,236
Total value		$19,634,393

Lake County

Mineral production in Lake County in 1951 consisted of mercury, and sand and gravel.

Lassen County

Sand and gravel	157,279 short tons	$90,027
Unapportioned: Granite, stone		22,550
Total value		$112,577

Los Angeles County

Clay	466,820 short tons	$381,148
Gold	310 troy ounces	10,850
Natural gas	115,969,311 M cu. ft.	15,334,043
Natural gasoline	6,314,214 barrels	19,782,000
Liquefied petroleum gases	706,463 barrels	1,274,000
Petroleum	99,237,746 barrels	229,431,437
Silver	177 troy ounces	160
Sand and gravel	15,820,669 short tons	11,012,775
Stone	3,417,258 short tons	2,278,376
Unapportioned: Cement, diatomite, granite, iodine, soapstone, titanium concentrates		4,610,810
Total value		$284,115,599

Mineral Production in California in 1951 by Counties—Continued

Madera County

Product	*Quantity*	*Value*
Copper	1,200 pounds	$290
Gold	617 troy ounces	21,595
Natural gas	2,934,141 M cu. ft.	536,948
Silver	172 troy ounces	155
Sand and gravel	17,569 short tons	19,102
Unapportioned: Pumice and pumicite, stone, tungsten concentrates		662,183
Total value		$1,240,273

Marin County

Mineral production in Marin County in 1951 consisted of clay, and stone.

Mariposa County

Mineral production in Mariposa County in 1951 consisted of lead, gold, platinum, quartz, slate, silver, sand and gravel, stone.

Mendocino County

Mineral production in Mendocino County in 1951 consisted of carbon dioxide and sand and gravel.

Merced County

Gold	4,768 troy ounces	$166,880
Silver	511 troy ounces	462
Sand and gravel, stone	535,267 short tons	376,514
Total value		$543,856

Modoc County

Sand and gravel	255,417 short tons	$60,367
Unapportioned: Gold, pumice, silver		184,483
Total value		$244,850

Mono County

Mineral production in Mono County in 1951 consisted of gold, pumice, silver, sand and gravel, stone, pyrophyllite.

Monterey County

Petroleum	2,746,916 barrels	$2,973,108
Sand and gravel	878,022 short tons	1,543,582
Stone	79,050 short tons	87,914
Unapportioned: Dolomite, lime, magnesium salts, natural gas, salt, silica sand		2,451,706
Total value		$7,056,310

Napa County

Sand and gravel	27,118 short tons	$35,375
Unapportioned: Mercury, perlite, pumice, stone		631,278
Total value		$666,653

Nevada County

Gold	97,285 troy ounces	$3,404,975
Silver	31,280 troy ounces	28,310
Total value		$3,433,285

Orange County

Natural gas	31,685,262 M cu. ft.	$4,443,497
Natural gasoline	2,803,356 barrels	8,889,000
Liquefied petroleum gases	283,121 barrels	434,000
Petroleum	38,346,863 barrels	82,140,228
Sand and gravel	1,495,895 short tons	1,112,322
Stone	201,198 short tons	200,717
Unapportioned: Salt, and clay		169,331
Total value		$97,389,095

Mineral Production in California in 1951 by Counties—Continued

Placer County

Product	*Quantity*	*Value*
Gold	719 troy ounces	$25,165
Silver	543 troy ounces	492
Unapportioned: Clay, granite, sand and gravel, stone		421,162
Total value		$446,819

Plumas County

Mineral production in Plumas County in 1951 consisted of barite, gold, silver, and sand and gravel.

Riverside County

Clay	182,101 short tons	$510,653
Gold	37 troy ounces	1,295
Lead	51,100 pounds	8,840
Silver	1,207 troy ounces	1,092
Sand and gravel	1,266,103 short tons	1,348,058
Unapportioned: Antimony, cement, gypsum, iron ore, limestone, stone		16,556,609
Total value		$18,426,547

Sacramento County

Clay	20,687 short tons	$59,811
Gold	91,585 troy ounces	3,205,475
Natural gas	77,706,733 M cu. ft.	14,608,866
Silver	4,070 troy ounces	3,689
Sand and gravel	3,577,191 short tons	4,012,848
Unapportioned: Platinum, stone		373,871
Total value		$22,264,560

San Benito County

Mercury	971 flasks	$204,036
Sand and gravel	280,080 short tons	164,946
Unapportioned: Cement, clay (bentonite), dolomite, petroleum, stone		3,185,030
Total value		$3,554,012

San Bernardino County

Clay	32,760 short tons	$364,331
Copper	104,400 pounds	25,265
Gold	954 troy ounces	33,390
Lead	309,700 pounds	53,578
Silver	12,081 troy ounces	10,934
Sand and gravel	1,084,097 short tons	1,084,119
Talc	126,784 short tons	1,332,522
Stone incl. granite, limestone, and crushed stone	596,799 short tons	1,454,953
Zinc	132,400 pounds	24,097
Unapportioned: Borates, bromine, calcium chloride, cement, feldspar, iron ore, lime, lithia, natural gas, perlite, petroleum, potash, pumice and pumicite, salt, silica sand, soda ash, salt cake		51,182,210
Total value		$55,529,399

San Diego County

Dimension stone—granite	22,992 short tons	$87,341
Sand and gravel	1,788,145 short tons	2,501,378
Stone	242,054 short tons	378,223
Unapportioned: Clay, magnesium salts, salt		414,148
Total value		$3,381,090

San Joaquin County

Natural gas	5,465,038 M cu. ft.	$1,027,427
Sand and gravel	1,866,075 short tons	1,095,331
Unapportioned: Clay, gold, platinum, silver, stone		304,983
Total value		$3,027,741

Mineral Production in California in 1951 by Counties—Continued

San Luis Obispo County

Product	*Quantity*	*Value*
Natural gas	1,308,512 M cu. ft.	$131,074
Natural gasoline	189,059 barrels	619,000
Liquefied petroleum gas	261,392 barrels	482,000
Petroleum	3,741,575 barrels	9,480,379
Sand and gravel	159,042 short tons	84,751
Stone	42,490 short tons	46,739
Other minerals		1,261
Total value		$10,845,204

San Mateo County

Product	*Quantity*	*Value*
Gold	4 troy ounces	$140
Silver	1 troy ounce	1
Stone	735,636 short tons	671,000
Unapportioned: Cement, limestone, magensium salts, sand and gravel		6,119,397
Total value		$6,790,538

Santa Barbara County

Product	*Quantity*	*Value*
Natural gas	29,289,351 M cu. ft.	$3,197,980
Natural gasoline	730,819 barrels	2,279,000
Liquefied petroleum gases	594,306 barrels	880,000
Petroleum	38,652,268 barrels	80,757,134
Unapportioned: Clay, diatomite, sand and gravel, stone		7,003,200
Total value		$94,117,314

Santa Clara County

Product	*Quantity*	*Value*
Sand and gravel	550,013 short tons	$570,054
Unapportioned: Cement, clay, limestone (shells), magnesite, mercury, petroleum, stone		19,787,199
Total value		$20,357,253

Santa Cruz County

Mineral production in Santa Cruz County in 1951 consisted of cement, limestone, sand and gravel, stone.

Shasta County

Product	*Quantity*	*Value*
Copper	879,800 pounds	$212,912
Gold	3,378 troy ounces	118,230
Lead	1,388,200 pounds	240,159
Silver	148,543 troy ounces	134,439
Sand and gravel	381,485 short tons	306,225
Stone	184,474 short tons	150,620
Zinc	6,119,600 pounds	1,113,767
Unapportioned: Asbestos, chromite, platinum, pyrite		993,378
Total value		$3,269,730

Sierra County

Product	*Quantity*	*Value*
Copper	100 pounds	$24
Gold	17,645 troy ounces	617,575
Silver	3,483 troy ounces	$3,152
Sand and gravel	2,687 short tons	11,800
Total value		$632,551

Siskiyou County

Product	*Quantity*	*Value*
Copper	100 pounds	$24
Gold	4,101 troy ounces	143,535
Pumice and scoria	26,384 short tons	91,385
Silver	506 troy ounces	458
Stone	195,876 short tons	129,124
Unapportioned: Chromite, sand and gravel		162,212
Total value		$526,738

Mineral Production in California in 1951 by Counties—Continued

Solano County

Product	*Quantity*	*Value*
Natural gas	52,237,400 M cu. ft.	$9,831,079
Stone	211,212 short tons	226,173
Total value		$10,057,252

Sonoma County

Stone	90,805 short tons	$121,588
Unapportioned: Mercury, petroleum, sand and gravel		1,401,697
Total value		$1,523,285

Stanislaus County

Sand and gravel	505,312 short tons	$431,185
Unapportioned: Clay, gold, natural gas, silver, stone		278,226
Total value		$709,411

Sutter County

Sand and gravel	83,880 short tons	$43,790
Unapportioned: Clay, natural gas		168,504
Total value		$212,294

Tehama County

Mineral production in Tehama County in 1951 consisted of sand and gravel.

Trinity County

Copper	3,200 pounds	$774
Gold	7,771 troy ounces	271,985
Sand and gravel incl. stone	12,498 short tons	35,137
Silver	827 troy ounces	748
Total value		$308,644

Tulare County

Copper	400 pounds	$97
Natural gas	4,876,910 M cu. ft.	872,967
Silver	37 troy ounces	34
Sand and gravel	432,209 short tons	466,314
Unapportioned: Clay, petroleum, stone, tungsten concentrates		315,258
Total value		$1,654,670

Tuolumne County

Copper	300 pounds	$73
Gold	314 troy ounces	10,990
Silver	81 troy ounces	73
Unapportioned: Limestone, lime, sand and gravel, stone		1,009,801
Total value		$1,020,937

Ventura County

Natural gas	74,029,894 M cu. ft.	$8,157,165
Natural gasoline	2,603,902 barrels	7,337,000
Liquefied petroleum gases	1,182,493 barrels	1,980,000
Petroleum	37,185,979 barrels	91,693,553
Sand and gravel	1,189,330 short tons	864,487
Unapportioned: Clay, gypsum, limestone, stone		404,866
Total value		$110,437,071

Mineral Production in California in 1951 by Counties—Continued

Yolo County

Product	*Quantity*	*Value*
Natural gas	2,935,080 M cu. ft.	$498,964
Sand and gravel	366,345 short tons	245,701
Other minerals		210
Total value		$744,875

Yuba County

Product	*Quantity*	*Value*
Gold	48,746 troy ounces	$1,706,110
Silver	3,219 troy ounces	2,913
Sand and gravel	227,367 short tons	232,365
Total value		$1,941,388

DIRECTORY OF PRODUCERS OF METALLIC AND NONMETALLIC MINERALS IN CALIFORNIA DURING 1951

(Producers of natural gas and petroleum may be found in the Summary of Operations, California Oil Fields, July-Dec. 1951, vol. 37, no. 2, of the State Division of Oil and Gas)

Nonmetallic Minerals

Asbestos (Tremolite)

Operator	Address	Location
Shasta County:		
Powhatan Mining Co.	Woodlawn, Baltimore 7, Maryland	Hazel Creek

Barite

Operator	Address	Location
Plumas County:		
Barium Products, Ltd.	Box 8-A, Newark	Almanor

Borates

Operator	Address	Location
Inyo County:		
Pacific Coast Borax Co.	P.O. Box 9128, Sta. S, Los Angeles 5	Shoshone
United States Borax Co.	630 Shatto Pl., Los Angeles 5	Shoshone
Kern County:		
Pacific Coast Borax Co.	P.O. Box 9128, Sta. S, Los Angeles 5	Boron
San Bernardino County:		
American Potash and Chemical Corp.	3030 W. Sixth St., Los Angeles 54	Trona
West End Chemical Co.	608 Latham Square Bldg., Oakland 12	Westend

Nonmetallic Minerals—Continued

Bromine

Operator	Address	Location
Alameda County:		
Westvaco Chemical Div. Food Machinery and Chemical Corp.	405 Lexington Ave., New York 17, N. Y.	Newark
San Bernardino County:		
American Potash and Chemical Co.	3030 W. Sixth St., Los Angeles 54	Trona

Calcium Chloride

Operator	Address	Location
San Bernardino County:		
California Salt Co.	2436 Hunter St., Los Angeles 21	Amboy
Hill Brothers Chemical Co.	2159 Bay St., Los Angeles 21	Amboy
National Chloride Company of America	354 S. Spring St., Los Angeles 13	Amboy

Carbon Dioxide Gas

Operator	Address	Location
Imperial County:		
Cardox Western, Inc.	151 N. Avenue 19, Los Angeles 31	Niland
Mendocino County:		
Caldri Ice Corp.	Old River Rd., Hopland	Hopland

Nonmetallic Minerals—Continued

Cement

Operator	Address	Location
Calaveras County:		
Calaveras Cement Co.	315 Montgomery St., San Francisco 6	San Andreas
Kern County:		
Monolith Portland Cement Co.	Box 3947, Glassell Sta., Los Angeles 65	Monolith
Los Angeles County:		
Blue Diamond Corp.	1650 S. Alameda St., Los Angeles 54	Los Angeles
Riverside County:		
Riverside Cement Co.	621 S. Hope St., Los Angeles 17	Crestmore
San Benito County:		
Pacific Portland Cement Co., c/o Ideal Cement Co.	821 17th St., Denver 2, Colo.	San Juan Bautista
San Bernardino County:		
California Portland Cement Co.	612 S. Flower St., Los Angeles 17	Colton
Riverside Cement Co.	621 S. Hope St., Los Angeles 17	Oro Grande
Southwestern Portland Cement Co.	1034 Wilshire Blvd., Los Angeles 17	Victorville
San Mateo County:		
Pacific Portland Cement Co., c/o Ideal Cement Co.	821 17th St., Denver 2, Colo.	Redwood City
Santa Clara County:		
Permanente Cement Co.	Permanente	Permanente
Santa Cruz County:		
Santa Cruz Portland Cement Co.	324 Crocker Bldg., San Francisco 4	Davenport

Nonmetallic Minerals—Continued

Clay

Including producers of crude clay, fire clay, kaolin, bentonite, oil well drilling mud, and miscellaneous clay

Operator	Address	Location
Alameda County:		
California Pottery Co. (miscellaneous clay)	P.O. Box 68, Niles	Niles
Interlocking Roof Tile Co. (miscellaneous clay and shale)	Box 488, Niles	Niles
Kraftile Co. (miscellaneous clay)	Niles	Niles
M & S Tile Co. (miscellaneous clay)	Second and E Sts., Decoto	Decoto
Amador County:		
Gladding, McBean & Co. (fire clay)	2901 Los Feliz Blvd., Los Angeles 26	Ione
Pacific Clay Products Co. (fire clay)	P.O. Box 145, Sta. A, Los Angeles 31	Ione
Western Refractories Co. (fire clay)	P.O. Box 169, Ione	Ione
Calaveras County:		
California Pottery Co. (miscellaneous clay)	P.O. Box 68, Niles	Valley Springs
Pacific Clay Products Co. (fire clay)	Box 145, Sta. A, Los Angeles 31	Valley Springs
Contra Costa County:		
Port Costa Brick Works, C. G. Berg, Pres. (miscellaneous clay and shale)	401 Berry St., San Francisco 7	Port Costa
United Materials & Richmond Brick Co., Ltd. (miscellaneous clay and shale)	Box 7, Richmond	Richmond
Fresno County:		
Craycroft Brick Co., (miscellaneous clay)	P.O. Box 814, Fresno	Fresno
Humboldt County:		
Hindley Clay Products (miscellaneous clay)	3121 Essex St., Eureka	Cutten
Imperial County:		
Radiant Minerals, Inc. (bentonite)	P.O. Box 359, Tacoma, Wash.	El Centro
Inyo County:		
Sierra Talc & Clay Co. (bentonite and fuller's earth)	5509 Randolph Ave., Los Angeles 22	Olancha
Silicates Corp. (bentonite)	230 Park Ave., New York, N. Y.	Death Valley Junction

Nonmetallic Minerals—Continued

Clay—Continued

Operator	Address	Location
Kern County:		
American Mineral Co. (kaolin or china clay)	2770 E. Eighth St., Los Angeles 23	Cantil
Excel Minerals Co. (fullers earth)	115 E. LaVerne Ave., Pomona	Taft
Kernco Materials Co. (oil-well drilling mud)	P.O. Box 1202, Bakersfield	Muroc
Macco Corp., Drilling Mud Division (oil-well drilling mud)	14409 S. Paramount Blvd., Paramount	Rosamond
McKittrick Mud Co. (oil-well drilling mud)	Box 356, McKittrick	McKittrick
Mojave Corp. (oil-well drilling mud)	P.O. Box 174, Los Nietos	Muroc
Los Angeles County:		
Angulo Tile Co. (miscellaneous clay)	19044 Kittridge St., Reseda	Reseda
Atkinson Brick Co. (miscellaneous clay)	13633 Central Ave., Los Angeles 2	Los Angeles
Atlas Sewer Pipe Co. (miscellaneous clay and adobe)	10009 S. Painter St., Whittier	Whittier
J. C. Booth (miscellaneous clay)	1775 Stanford Ave., Santa Monica	Santa Monica
Builders Brick Co. (miscellaneous clay)	P.O. Box 266, Gardena	Compton
Castaic Brick Co. (miscellaneous clay and shale)	Castaic	Castaic
Davidson Brick Co. (miscellaneous clay)	4701 Floral Dr., Los Angeles 22	Los Angeles
Gladding McBean & Co. (miscellaneous clay)	2091 Los Feliz Blvd., Los Angeles 26	Tropico, Los Angeles, Santa Monica & Pico
Higgins Brick & Tile Co. (miscellaneous clay)	P.O. Box 1125, Sta. A., Gardena	Moneta
Pacific Brick Co. (miscellaneous clay and shale)	P.O. Box 1125, Sta. A., Gardena	Santa Monica
Pacific Clay Products (miscellaneous clay, shale)	Box 145, Sta. A., Los Angeles 31	Los Angeles and Los Nietos
Pomona Brick Co., S. Bernard Strona (miscellaneous clay and shale)	Ninth and Buena Vista, Pomona	Pomona
San Valle Tile Kilns (miscellaneous clay, alluvium)	1258 N. Highland Ave., Los Angeles 38	Reseda
Simons Brick Co., W. R. Simons (miscellaneous clay, shale, and adobe)	6677 Anaheim-Telegraph Rd., Los Angeles 22	Los Angeles
Valley Brick & Supply Co. (miscellaneous clay and loam)	6151 Kester Ave., Van Nuys	Van Nuys
Marin County:		
McNear Brick Co., (miscellaneous clay and shale)	McNear Point, San Rafael	McNear Point
Orange County:		
I. P. Arnold (kaolin or china clay and fire clay)	7655 W. Second St., Downey, Los Angeles	El Toro
Gladding McBean & Co. (fire clay)	2910 Los Feliz Blvd., Los Angeles 26	Irvine, Claymont, Prado
La Bolsa Tile Co. (miscellaneous clay)	R.F.D. 18404 Gothard St., Huntington Beach	Smeltzer

Placer County:		
Gladding McBean & Co. (fire clay)	2901 Los Feliz Blvd., Los Angeles 26	Lincoln
Lincoln Clay Products Co. (fire clay)	P.O. Box 367, Lincoln	Lincoln
Riverside County:		
Alberhill Coal & Clay Co. (fire clay and miscellaneous clay)	P.O. Box 14005, Barrington Sta., Los Angeles 24	Alberhill
Gladding McBean & Co., (fire clay and miscellaneous clay)	2901 Los Feliz Blvd., Los Angeles 26	Sloan
Liston Brick Co. (miscellaneous clay)	Corona	Corona
Los Angeles Brick & Clay Products Co., (fire clay and miscellaneous clay)	1078 Mission Rd., Los Angeles 33	Alberhill
Pacific Clay Products (fire clay and miscellaneous clay)	Box 145, Sta. A., Los Angeles 31	Corona
Temescal Clay Co., (fire clay)	Suite 309, 6308 Pacific Blvd., Huntington Park	Temescal
Tillotson Refractories Co. (fire clay)	1150 W. Sixth St., Corona	Corona
Sacramento County:		
Cannon & Co., (fire clay and miscellaneous clay)	Box 802, Sacramento 4	Ben Ali and Michigan Bar
Harrison Fait (adobe)	1950 Howe St., North Sacramento	North Sacramento
Sacramento Brick Co. (miscellaneous clay and adobe)	P.O. Box 844, Sacramento 4	Sacramento
Western Refractories Co. (fire clay)	P.O. Box 169, Ione	Folsom
San Benito County:		
C. Hyde Lewis (bentonite)	Idria	Vallecitos
San Benito Bentonite Co. (bentonite)	111 Brookside Ave., San Jose	Tres Pinos
San Bernardino County:		
Baroid Sales Div., National Lead Co. (bentonite)	P.O. Box 2558, Terminal Annex, Los Angeles 54	Hector
Gladding McBean & Co. (kaolin or china clay)	2901 Los Feliz Blvd., Los Angeles 26	Goff
Hancock Brick Yard, C. P. Hancock & Son (miscellaneous clay and adobe)	Box 421, Riverside	Highgrove
Inerto Co. (bentonite)	1489 Folsom St., San Francisco 3	Newberry
Marter Mining Co. (miscellaneous clay)	143 N. Rosemont Blvd., San Gabriel	Bryman
Southern California Minerals Co., W. K. Skeoch (kaolin & china clay)	320 S. Mission Rd., Los Angeles 33	Goff
San Diego County:		
La Jolla Canyon Clay Products (miscellaneous clay)	P.O. Box 712, La Jolla	La Jolla
Union Brick Co., (miscellaneous clay and shale)	2351 Pacific Highway, San Diego 9	Rose Canyon
San Joaquin County:		
Stockton Brick & Tile Co. (miscellaneous clay)	P.O. Box 547, Stockton	Stockton
Stockton Building Materials (miscellaneous clay)	711 S. Madison St., Stockton 4	Stockton
Santa Barbara County:		
McNall Building Materials (miscellaneous clay and shale)	P.O. Box 758, Santa Barbara	Santa Barbara

Nonmetallic Minerals—Continued

Clay—Continued

Operator	Address	Location
Santa Clara County:		
Gladding Bros. Mfg. Co. (miscellaneous clay and fire clay)	S. Third and Keyes St., San Jose 12	San Jose
Remillard-Dandini Co. (miscellaneous clay)	321 13th St., Oakland 12	San Jose
San Jose Brick & Tile Co. (miscellaneous clay)	321 13th St., Oakland 12	San Jose
Stanislaus County:		
Harry Chase (fire clay)	Box 37, Knights Ferry	Knights Ferry
Lester Raggio (fire clay)	Box 22, Knights Ferry	Cooperstown
Sutter County:		
Gladding McBean & Co. (miscellaneous clay)	2901 Los Feliz Blvd., Los Angeles 26	Nicolaus
Tulare County:		
S.P. Brick & Tile Co. (miscellaneous clay)	P.O. Box 568, Fresno	Exeter
Ventura County:		
Rocklite Products (shale)	1800 N. Ventura Ave., Ventura	Ventura
Shell Oil Co., Dent Clay pit (oil-well drilling mud)	Shell Bldg., San Francisco	Ventura
Tidewater Associated Oil Co., (oil-well drilling mud)	79 New Montgomery St., San Francisco	Ventura

Nonmetallic Minerals—Continued

Coal

Operator	Address	Location
Amador County:		
American Lignite Products Co.	Ione	Ione

Diatomite (Diatomaceous Earth)

Operator	Address	Location
Inyo County:		
Hazen Mining Co.	Independence	Independence
Los Angeles County:		
Great Lakes Carbon Corp. Dicalite Division	612 S. Flower St., Los Angeles 14	San Pedro
Santa Barbara County:		
Johns-Manville Products Corp.	22 E. 40th St., New York,16 N. Y.	Lompoc

Feldspar

Operator	Address	Location
San Bernardino County:		
Gladding McBean & Co.	2901 Los Feliz Blvd., Los Angeles 26	Atolia

Nonmetallic Minerals—Continued

Granite (dimension stone)

Operator	Address	Location
Fresno County:		
Superior Academy Granite Co.	Box 68, Clovis	Academy
Lassen County:		
J. B. Wagender	805 Weatherlow St., Susanville	Susanville
Los Angeles County:		
H. A. Jones	215 W. Green St., Pasadena	Bouquet Canyon
Placer County:		
Union Granite	Rocklin	Rocklin
San Bernardino County:		
W. H. Johnson	Box 605, Victorville	Victorville
San Diego County:		
California Cut Stone	Railroad Ave., at Magnolia, South San Francisco	Vista
D. B. Clemens	3600 Suncrest Blvd., El Cajon	Suncrest
National Quarries	923 Park Hill Dr., Escondido	Escondido
Pacific Cut Stone & Granite Co.	414 S. Marengo Ave., Alhambra	Escondido
Southern California Granite Co.	3845 Imperial Ave., San Diego 13	Foster
John Striburg (deceased)	Box 115, Escondido	Escondido
Valley Granite Co.	243 E. Fifth St., Escondido	Escondido

Nonmetallic Minerals—Continued

Gypsum

Operator	Address	Location
Alameda County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (output not included in production figures as gypsum is by-product of chemical process using minerals already included in state total)	405 Lexington Ave., New York, N. Y.	Newark
Fresno County:		
Agricultural Mineral & Fertilizer Co., A. D. Sousa	P.O. Box 832, Los Banos	Los Banos
Edward Jones	P.O. Box 887, Dos Palos	Firebaugh
Imperial County:		
United States Gypsum Co.	300 W. Adams St., Chicago 6, Ill.	Plaster City
Kern County:		
Carrisa Gypsum Mine, C. L. Fannin	Rt. 1, Box 7, Wasco	Wasco
H. M. Holloway	Box 310, Lost Hills	Lost Hills
Pacific Gypsum Co., W. D. Fowler	P.O. Box 563, Bakersfield	Conner
Western Gypsum Co.	773 Maple St., Wasco	McKittrick
Kings County:		
H. M. Holloway	Box 310, Lost Hills	Avenal
Riverside County:		
United States Gypsum Co.	300 W. Adams St., Chicago 6, Ill.	Midland
Ventura County:		
Monolith Portland Cement Co.	Box 3947 Glassell Sta., Los Angeles 65	Quatal Canyon

Nonmetallic Minerals—Continued

Iodine

Operator	Address	Location
Los Angeles County:		
Deepwater Chemical Co., Ltd.	Box 588, Compton	Compton
Great Western Division, The Dow Chemical Company	P.O. Box 245, Seal Beach	Long Beach, Venice, and Seal Beach

Lime, Limestone, and Shells

Operator	Address	Location
El Dorado County:		
California Rock & Gravel Co. (industrial limestone)	1800 Hobart Bldg., San Francisco	Newcastle
Diamond Springs Lime Corp. (producer of burnt lime, industrial limestone, and agricultural lime)	Box 409, Diamond Springs	Diamond Springs
El Dorado Limestone Co., J. H. Bell, President (industrial lime)	Shingle Springs	Shingle Springs
Hughes-Vertin Lime Co. (producer of burnt lime, industrial limestone, agricultural lime, and lime materials used in rough construction)	Box 231, Auburn	Newcastle
Monterey County:		
Kaiser Aluminum & Chemical Corp. (producer of burnt lime and dolomite)	Box 1531, Salinas	Salinas
Riverside County:		
Riverside Cement Co. (industrial limestone)	621 S. Hope St., Los Angeles 17	Crestmore
San Benito County:		
Westvaco Chemical Div., Food Machinery Corp. (dolomite)	405 Lexington Ave., New York, N. Y.	Hollister

San Bernardino County:		
California Portland Cement Co. (producer of burnt lime and industrial limestone)	612 S. Flower St., Los Angeles 17	Colton
Riverside Cement Co. (industrial limestone)	621 S. Hope St., Los Angeles 17	Oro Grande
Victorville Lime Rock Co. (industrial limestone)	Box 548, Victorville	Victorville
West End Chemical Co. (producer of burnt lime, and industrial limestone)	608 Latham Square, Oakland 12	Westend
White Lime Rock Co. (industrial limestone)	5953 Crenshaw Blvd., Los Angeles 43	Victorville
San Mateo County:		
California Aggregates (crushed limestone)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Santa Clara County:		
Bay Shell Co. (agricultural lime and shells)	1583 E. 14th St., Oakland	Alviso
Santa Cruz County:		
Pacific Limestone Prod. Co. (industrial limestone and agricultural lime)	445 Spring St., Santa Cruz	Santa Cruz
Rhodes & Robinson (crushed limestone)	Box 325, Palo Alto	
Santa Cruz Portland Cement Co. (industrial limestone)	327 Crocker Bldg., San Francisco	Davenport
Tuolumne County:		
Sonora Marble Aggregates Co. (industrial limestone)	356 Church St., San Francisco	Sonora
U. S. Lime Products Corp. (producers of burnt lime, industrial limestone, and agricultural lime)	175 S. Alvarado St., Los Angeles 4	Sonora
Ventura County:		
Western Lime Products Co. (industrial limestone and agricultural lime)	102 N. Brand Blvd., Glendale 3	Santa Susana

Lithia

Operator	Address	Location
San Bernardino County:		
American Potash & Chemical Corp.	3030 W. Sixth St., Los Angeles 54	Trona

Nonmetallic Minerals—Continued

Magnesia and Other Magnesium Compounds

Operator	Address	Location
Alameda County:		
Pabco Products, Inc. (carbonate)	1550 Powell St., Emeryville 8	Emeryville
Westvaco Chemical Division, Food Machinery & Chemical Corp. (oxide)	405 Lexington Ave., New York 17, N. Y.	Newark
Monterey County:		
Kaiser Aluminum & Chemical Corp. (oxide)	Box 1531, Salinas	Moss Landing
San Diego County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (chloride)	405 Lexington Ave., New York 17, N. Y.	Chula Vista
San Mateo County:		
Johns-Manville Products Corp. (carbonate)	22 E. 40th St., New York 16, N. Y.	Redwood City
Marine Magnesia Products Division, Merck & Co., Inc. (carbonate, hydroxide, and oxide)	E. Grand Ave., South San Francisco	South San Francisco

Magnesite

Operator	Address	Location
Santa Clara County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp.	405 Lexington Ave., New York 17, N. Y.	Red Mountain

Peat

Operator	Address	Location
Contra Costa County:		
Pacific Natural Products Co., F. Koser	P.O. Box 1201, Richmond	Antioch
Modoc County:		
Modoc Peat Moss Co.	604 Mission St., San Francisco 5	Likely
Orange County:		
R. W. McClellan and Sons	151 Commercial Way, Costa Mesa	Costa Mesa
Peat Sales Co., D. M. Callis, Jr.	17581 Gothard Rd., Huntington Beach	Huntington Beach

Nonmetallic Minerals—Continued

Perlite

Operator	Address	Location
Contra Costa County:		
American Perlite Corp. (expanded)	26th and B Sts., Richmond	Richmond
Inyo County:		
U. S. Mining Corp., (crude)	6363 Wilshire Blvd., Los Angeles	Fish Springs
Los Angeles County:		
Coast Perlite Co., Inc., (expanded)	650 S. Clarence St., Los Angeles	Los Angeles
Great Lakes Carbon Corp., (expanded)	18 E. 48th St., New York, N. Y.	Torrance
Panacalite Pacific, Inc. (expanded)	825 E. 60th St., Los Angeles 11	Los Angeles
Paramount Perlite Co., Inc. (expanded)	16236 S. Illinois, Paramount	Paramount
Peerless Perlite Co., (expanded)	2807 S. Fairfax, Los Angeles 16	Los Angeles
Redco, Inc. (expanded)	11831 Vose St., North Hollywood	North Hollywood
U. S. Perlite Co. (expanded)	609 S. Grand Ave., Los Angeles 14	Los Angeles
Marin County:		
Perolite Products Corp. (expanded)	P.O. Box 175, Sausalito	Sausalito
Napa County:		
Napa Perlite Co., (crude)	300 Montgomery St., San Francisco	St. Helena
Perlite Aggregates, Inc. (crude and expanded)	St. Helena	St. Helena
San Bernardino County:		
More-Lite Co. (crude)	P.O. Box 101B, RD 5, Riverside	
Nulite Insulated Homes, Inc. (expanded)	Box 216, Fontana	Fontana

Potash

Operator	Address	Location
San Bernardino County:		
American Potash and Chemical Co.	3030 W. Sixth St., Los Angeles 54	Trona

Nonmetallic Minerals—Continued

Pumice and Pumicite

Operator	Address	Location
Calaveras County:		
Irvine Lava Quarry, Robert B. Irvine (pumice)	P.O. Box 47, Gonzales	Mokelumne Hill
Sonora Marble Aggregates Co. (pumice)	Rt. 1, Box 599, Chinese Camp	
H. D. Warren Pumice Plant (pumice)	Rt. 1, Box 295, Linden	Burson
Imperial County:		
Superlite Corp. (pumice)	P.O. Box 758, Calipatria	Calipatria
Inyo County:		
Crownite Corp. (pumice)	6363 Wilshire Blvd., Los Angeles 48	Coso Junction
Desert Materials Corp. (pumice)	6363 Wilshire Blvd., Los Angeles 48	Inyokern
H. B. Jarvis (pumice)	P.O. Box 5, Little Lake	Little Lake
Kern County:		
Calsilco Corp. (pumice, pumicite, or volcanic ash)	2372 S. Atlantic Blvd., Los Angeles	Red Rock Canyon
Madera County:		
California Industrial Mineral Co. (pumicite or volcanic ash)	Friant	Friant
Elmer Erickson (pumice)	Star Rt., Box 1, Fresno 7	Friant
Modoc County:		
Glass Mt. Volcolite Co., H. W. Free (pumice)	Tionesta	Glass Mountain
Mono County:		
Bishop Hardware & Supply Co. (pumice)	Box 1013, Bishop	Laws
Insulating Aggregate Co., G. M. M. Grant (pumice)	Box 884, Bishop	Laws
U. S. Pumice Supply Co. (pumice, scouring blocks)	5509 Randolph St., Los Angeles 22	Leevining
Napa County:		
Basalt Rock Co. (pumice)	P.O. Box 540, Napa	Napa
San Bernardino County:		
Western Talc Co. (pumicite or volcanic ash)	1901 E. Slauson Ave., Los Angeles 58	Yermo
Williams Bros. (pumice)	Star Route 1, Barstow	Hinckley

Siskiyou County:		
Boorman Pumice Products (pumice)	Tionesta	Glass Mountain
Glass Mt. Volcolite Co., H. W. Free (pumice, scouring blocks)	Tionesta	Glass Mountain
John Madsen (Skoria Star Brick Co.) (pumice, scouring blocks)	P.O. Box 711, Klamath Falls, Ore.	Glass Mountain
J. H. Scott Co. (pumice)	Merchants Exchange Bldg., San Francisco 4	Tennant
Shastalite Block Co. (pumice)	P.O. Box 914, Yreka	Cinder Cone Mt.
Thompson Pumice Co. (pumice)	Tionesta	Glass Mountain
Dan Williams (pumice)	221 Katherine St., Salinas	Mt. Hoffman

Pyrite

Operator	Address	Location
Shasta County:		
The Mountain Copper Co., Ltd., L. T. T. Kett, Jr., Mgr.	216 Pine St., San Francisco	Matheson

Salt

Operator	Address	Location
Alameda County:		
American Salt Co.	341 Broadway, San Francisco 11	Mt. Eden
Leslie Salt Co.	505 Beach St., San Francisco 11	Newark and Mt. Eden
Morton Salt Co.	120 S. LaSalle St., Chicago, Ill.	Newark
Oliver Bros. Salt Co.	Mt. Eden	Mt. Eden
Monterey County:		
Monterey Bay Salt Works, E. C. Vierra, Mgr.	Box 43, Moss Landing	Moss Landing
Orange County:		
Western Salt Co.	1245 National Ave., San Diego 12	Newport Beach
San Bernardino County:		
California Salt Co.	2436 Hunter St., Los Angeles 21	Amboy
Pacific Salt & Chemical Co.	1517 E. Olympic Blvd., Los Angeles 21	Trona
San Diego County:		
Western Salt Co.	1245 National Ave., San Diego 12	Chula Vista

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous

Under the heading of "miscellaneous stone" are four divisions—crushed rock, grinding mill pebbles, paving blocks, and sand and gravel. Crushed rock includes crushed rock that is used in macadam, ballast, and for concrete; also rock used for rubble and riprap.

NOTE—The California State Highway Commission, the various counties, cities, U. S. Engineers, U. S. Bureau of Reclamation, U. S. Forest Service, U. S. National Park Service, and U. S. Bureau of Public Roads produce both crushed rock and sand and gravel in various places in the state used in construction and maintenance of highways, but not specified in this listing.

Operator	Address	Location
Alameda County:		
Bell Sand & Gravel, Stanley L. and Anna L. Bell (sand and gravel)	P.O. Box 282, Irvington	Irvington
California Rock & Gravel Co. (sand and gravel)	1800 Hobart Bldg., San Francisco	Livermore
Concrete Materials Co. (sand and gravel)	1401 Illinois St., San Francisco	Pleasanton
Heafey-Moore Co., Div. Gallagher & Burk, Inc. (crushed rock—macadam, fill rock, ballast)	6900 Mountain Rd., Oakland	Oakland
Inland Aggregates Co., Inc. (sand and gravel)	P.O. Box 236, Niles	Niles
Henry J. Kaiser Co. (sand and gravel, crushed rock)	Kaiser Bldg., 1924 Broadway, Oakland	Radum and Niles
Leslie Salt Co. (riprap)	505 Beach St., San Francisco	Newark
Niles Quarry Co. (crushed rock, fill rock)	Box 507A, 4061 Highland Blvd., Niles	Niles
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Eliot and Centerville
San Leandro Rock Co. (crushed rock, fill rock)	1575 Lake Chabot Rd., San Leandro	Lake Chabot
Butte County:		
Butte Creek Rock Co. (sand and gravel)	Centerville Rd., Chico	Chico
Henry J. Kaiser Co. (sand and gravel, crushed rock—macadam, ballast, rubble, riprap, etc.)	1924 Broadway, Oakland	Oroville
Roy Mathews Gravel Plant (sand and gravel)	Rt. 1, Box 23, Gridley	Gridley
Calaveras County:		
Neilsen Sand & Gravel Co. (sand and gravel)	Box 14, San Andreas	San Andreas
Colusa County:		
Cortina Sand, Gravel and Silt; Gene Godin (sand and gravel)	Colusa	Colusa
Paul Entremont (sand and gravel)	Box 208, Colusa	Wohlfrem Ranch
C. W. & D. O. McKasson (sand and gravel)	Rt. 1, Box 11, Colusa	Princeton
Contra Costa County:		
Alves Quarry (crushed rock, fill rock)	P.O. Box 97, Pittsburg	Pittsburg
Basalt Rock Co. (sand and gravel)	Eighth and River Sts., Napa	Antioch
Blake Bros. Anson Blake (crushed rock, ballast, riprap)	Box 1002, Richmond	Point Richmond
Henry J. Kaiser Co. (sand and gravel, crushed rock)	1924 Broadway, Oakland	Antioch
Marchio Sand Co. (molding sand)	Antioch	Antioch
Morris Sand Pit, Ben Morris (sand and gravel)	Rt. 1, Box 659, Antioch	Antioch
Serra Bros. (crushed rock, fill rock)	R.F.D. Rt. 1, Box 355, Martinez	Walnut Creek

Del Norte County:		
John Burman & Sons (sand and gravel)	2750 Harrison, Eureka	
E. H. Chapman (sand and gravel)	Klamath	Klamath
Stimpson Logging Co. (sand and gravel)	Klamath	Klamath
El Dorado County:		
El Dorado Rock & Sand, Jerry Brown & Son (sand and gravel)	Rt. 2, Box 187, Placerville	Placerville
Diamond Springs Lime Co. (crushed rock—macadam)	Diamond Springs	Diamond Springs
T. C. Nutt Quarry (flagstone)	Box 9, Placerville	Placerville
Ralph C. Young (flagstone)	Rt. 3, Box 252, Placerville	Placerville
Fresno County:		
Atchison, Topeka & Santa Fe Railway Co. (ballast, sand and gravel)	121 E. Sixth St., Los Angeles 14	Oakhurst, Piedra
Central Rock & Sand Co. (sand and gravel)	P.O. Box 425, Sanger	Sanger
L. D. Folsom (sand and gravel)	Box 347, Coalinga	Coalinga
Herndon Rock Products Co. (sand and gravel, crushed rock)	410 Thorne St., P.O. Box 886, Fresno	Herndon
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Rockfield
Sharp & Fellows Construction Co. (crushed rock—macadam, ballast)	533 Central Bldg., Los Angeles 14	Piedra
Thompson Materials (sand and gravel)	Bin J, Avenal	Coalinga
Glenn County:		
E. B. Bishop & Edward Thomas dba Orland Sand & Gravel Co. (sand and gravel)	P.O. Box 469, Orland	Orland
Southern Pacific Co. (sand and gravel)	65 Market St., San Francisco	Wyo
Humboldt County:		
Eureka Sand & Gravel Co. (sand and gravel)	1920 Williams St., Eureka	Eureka
Kelly & McWhorter (sand and gravel)	P.O. Box 572, Fortuna	Eureka
Mercer Fraser Co., Inc. (sand and gravel)	Second and Commercial Sts., Eureka	Essex & Fernbridge
Northwestern Pacific R.R. Co. (sand and gravel)	San Rafael	Sequoia
Imperial County:		
Valley Transit Cement Co., Inc. (sand and gravel)	P.O. Box 1489, El Centro	El Centro
Kern County:		
C & H Materials Co. (sand and gravel)	Box 638, Oildale	Bakersfield
Edison Sand Co. (sand and gravel)	Box 395, Sta. A, Bakersfield	Bakersfield
Griffith Co. (sand and gravel)	Box 175, Sta. B, Bakersfield	Bakersfield
Hartman Concrete Materials (sand and gravel)	P.O. Box 1632, Bakersfield	Bakersfield and Maricopa
Kern Rock Co., Ltd. (sand and gravel, and crushed rock)	P.O. Box 1697, Bakersfield	Kern River
Union Paving Co. (sand and gravel)	681 Market St., San Francisco 4	
Kings County:		
Thompson Materials & Construction Co., Inc. (crushed rock)	Bin J, Avenal	Avenal
Lake County:		
Lange Bros. Sand and Gravel Plant, H. Lange & A. Lange (sand and gravel)	Box 66, Lakeport	Kelseyville

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Lassen County:		
Grayson Concrete & Materials (sand and gravel)	1512 Fourth St., Susanville	Susanville
Los Angeles County:		
Arrow Rock Co. (sand and gravel)	11670 Wicks St., Sun Valley	Monrovia and Sun Valley
Azusa Rock & Sand Co. (sand and gravel, crushed rock)	P.O. Box 575, Azusa	Azusa
Richard R. Ball (sand and gravel, filter sand)	Box 96, Walteria	Walteria
Blue Diamond Corp., Ltd. (sand and gravel)	P.O. Box 2678 Term. Annex Sta., Los Angeles 54	El Monte and Sun Valley
Wm. J. Bonfield (decomposed granite)	2008 Laurel Canyon Rd., Los Angeles 46	Sun Valley
California Materials Co. (sand and gravel, and crushed rock)	P.O. Box 110, Whittier	Whittier
Chandler Sand & Gravel, L. Chandler (sand and gravel)	Box 295, Lomita	Lomita
City Rock Co. (sand and gravel, crushed rock)	P.O. Box 8, Sunland	Sunland
Connolly-Case-Kiewit Co. (crushed rock)	2051 Del Amo Blvd., Compton	
Consolidated Rock Products Co. (sand and gravel, crushed rock)	Box 2950 Terminal Annex or 2730 S. Alameda St., Los Angeles	Los Angeles, Azusa, Roscoe, Monroe, Monrovia, Baldwin Park, and North Hollywood
Gordon Transfer Co. (sand and gravel)	907 Main St., El Segundo	El Segundo
Graham Bros., Inc. (sand and gravel, and crushed rock)	5500 N. Peck Rd., El Monte	El Monte
Granite Materials Co. (sand and gravel, decomposed granite)	12455 Wicks St., North Hollywood	Roscoe
Hanawalts (crushed rock, sand and gravel)	2175 San Bernardino Ave., Pomona	Pomona
Lindauer Corp. (sand and gravel)	Box 337, La Habra	La Habra
Livingston Truck & Materials Co. (decomposed granite)	3366 Cherry St., Long Beach 7	Rolling Hills
Los Angeles Decomposed Granite Co. (decomposed granite)	Box 39, Montebello	Montebello
Wm. R. Magoffin dba Caswell & Co. (sand and gravel)	2357 E. Slauson Ave., Los Angeles 58	Torrance
Manning Bros. Rock & Sand Co. (sand and gravel, crushed rock)	P.O. Box C, Irwindale	Irwindale
Miller Bros. Truck Co. (sand and gravel)	3451 Randolph St., Huntington Park	Huntington Park
Osburn Co. (sand and gravel)	2300 Edgecliff Lane, Pasadena	Pasadena
Owl Rock Products Co. (sand and gravel)	420 S. Alameda St., Compton	Monrovia
Pacific Rock & Gravel Co. (sand and gravel)	Box 778, Arcadia	Monrovia
Walter Ranson (sand and gravel)	3467 Greenfield Ave., Los Angeles 34	
Edward Sidebotham & Sons, Inc. (sand and gravel)	South End Penn Ave., Lomita	Lomita
Sierra Rock Products (sand and gravel)	P.O. Box 216, Temple City	Temple City
Sparks & Mundo Engineering Co. (sand and gravel)	2727 E. Washington Blvd., Los Angeles	Monrovia
Marin County:		
Basalt Rock Co. (crushed rock, riprap)	Eighth and River Sts., Napa	McNear Point
Hutchinson Co. (crushed rock—macadam, rubble, riprap)	7360 Schmidt Lane, El Cerrito	San Rafael
Marin Gravel Co. (sand and gravel)	Box 11, Point Reyes Station	Point Reyes

Mariposa County:		
Geo. P., J. G., and E. C. Greenamger (sand and gravel)	Box N, Mariposa	Mariposa
Mendocino County:		
John Freitas, Ukiah Gravel & Cement Co. (sand and gravel)	P.O. Box 187, Ukiah	Ukiah
E. Walsh and M. Ford (sand and gravel	Box 74, Ukiah	Ukiah
Merced County:		
Los Banos Gravel Co. (sand and gravel)	P.O. Box 1111, Los Banos	Los Banos
River Rock Co. (sand and gravel)	20 E. 15th St., Merced	Merced
Turlock Rock Co. (sand and gravel)	P.O. Box 548, Turlock	Ballico
Modoc County:		
Moyer Gravel Co. (sand and gravel)	P.O. Box 25, Alturas	Alturas
Monterey County:		
Max Cozin (sand and gravel)	Box 9, Metz Rt., King City	King City
Del Monte Properties Co., C. S. Olmstead (sand and gravel, molding sand)	Pebble Beach	Pacific Grove
H. W. Kalar (sand and gravel)	Box 358, Marina	Marina
Monterey Sand Co. (sand and gravel, filter sand)	Box 928, Monterey	Seaside
M. J. Murphy, Inc. (sand and gravel)	P.O. Box 100, Carmel	Carmel
Pacific Coast Aggregates, Inc. (crushed rock)	400 Alabama St., San Francisco	Lapis and Prattco
Owens Illinois Glass Co. (glass sand)	350 Sansome St., San Francisco	Pacific Grove
Napa County:		
Basalt Rock Co. (crushed rock-macadam, riprap)	Eighth and River Sts., Napa	Napa
Benson Gravel Plant (sand and gravel)	Angwin	Pope Valley
Orange County:		
I. P. Arnold (sand)	7655 E. Second St., Downey	Santa Ana
Burris Sand Pit, Geo. T. Calhoun (sand)	Box 1741, Santa Ana	Anaheim
California Rock Co. (sand and gravel)	Rt. 3, Box 12111, Orange	Orange
Consolidated Rock Products Co. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Fullerton and Orange
Foster Sand & Gravel (sand and gravel)	915 S. Spadra Rd., Fullerton	Orange
A. E. Fowler & Sons (sand and gravel)	Rt. 3, 12705 Cambridge St., Orange	Orange
Graham Bros., Inc. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	5500 N. Peck Rd., El Monte	San Juan Capistrano
D. D. Lawhead & Sons (decomposed granite)	Seal Beach	Buena Park
McClelland & Son (sand and gravel)	151 Commercial Way, Costa Mesa	Anaheim
Sully-Miller Construction Co. (sand and gravel, crushed rock)	1500 W. Seventh St., Long Beach	El Modena
Placer County:		
Joe Chevreaux (sand and gravel)	P.O. Box 65, Station A, Auburn	Auburn
Union Granite Co., Ruhkala Bros. (crushed rock-macadam, ballast, rubble, riprap, etc.)	Rocklin	Rocklin

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Riverside County:		
A. T. & S. F. Ry. Co. (ballast)	121 E. Sixth St., Los Angeles 14	Box Springs
Guy F. Atkinson Co. (rubble, riprap)	P.O. Box 259, Long Beach	Bly Junction
Emil Johnson (crushed rock-macadam)	Rt. 2, Box 185, Escondido	Perris
Massey Rock & Sand Co. (sand and gravel)	Box 1065, Indio	Indio
Owens-Illinois Glass Co. (glass sand)	350 Sansome St., San Francisco	Corona
Palm Springs Bldrs. Supply Co. (sand and gravel)	490 Sunny Dunes Rd., Palm Springs	Whitewater
San Gorgonio Rock Products (sand and gravel)	1990 N. Hargrove St., Banning	Banning
Service Rock Co. (sand and gravel)	Box 309, Riverside	Riverside
Transit Mixed Concrete Co. (sand and gravel)	3464 E. Foothill Blvd., Pasadena	Corona
Valley Rock & Sand Corp. (sand and gravel)	Rt. 1, Box 198, San Jacinto	Moreno
Sacramento County:		
American River Sand & Gravel Co. (sand and gravel)	P.O. Box 156, Perkins	Perkins
Brighton Sand and Gravel Co. (sand and gravel)	P.O. Box 2604, Sacramento 10	Perkins
Del Paso Rock Products Co. (sand and gravel)	3490 Fair Oaks Blvd., Sacramento	Del Paso
Fair Oaks Gravel Co. (sand and gravel)	Rt. 1, Box 533, Illinois Ave., Fair Oaks 19	Fair Oaks
McGillivray Construction Co. (sand and gravel)	P.O. Box 873, Sacramento 4	Sacramento
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Fair Oaks, Prattrock and American River
Perkins Gravel Co. (sand and gravel)	1931 Stockton Blvd., Sacramento	Perkins
J. R. Reeves (sand and gravel, crushed rock-macadam, ballast, etc.)	P.O. Box 1072, Sacramento	Sacramento
San Benito County:		
Granite Rock Co. (crushed rock-macadam, ballast)	Box 151, Watsonville	Logan
Frederickson & Watson (crushed rock)	873 81st St., Oakland	----------
San Bernardino County:		
A. T. & S. F. Ry. Co. (crushed rock, ballast)	121 E. Sixth St., Los Angeles	Newberry
Consolidated Rock Products Co. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Claremont
Fontana Gravel Co. (sand and gravel)	P.O. Box 173, Fontana	Fontana
Fourth St. Rock Crusher (sand and gravel)	P.O. Box 469, San Bernardino	San Bernardino
Geo. Herz & Co. (sand and gravel)	P.O. Box 191, San Bernardino	San Bernardino
Holliday Rock Co. (sand and gravel)	P.O. Box 496, Upland	Upland and Colton
Redlands Gravel Co. (sand and gravel)	305 S. Buena Vista St., Redlands	Redlands
San Bernardino Rock & Gravel Co. (sand and gravel)	1910 W. Seventh St., San Bernardino	San Bernardino
Triangle Rock & Gravel Co. (sand and gravel)	P.O. Box 2098, San Bernardino	San Bernardino
Tri-City Rock Co. (sand and gravel)	P.O. Box 789, Redlands	Redlands

San Diego County:		
Charles & Victor Arnell, Lakeside Sand Plant (sand and gravel)	Rt. 1, Box 10, Lakeside	Lakeside
Canyon Rock Co. (sand and gravel, crushed rock)	Box F, Hillcrest Sta., San Diego 3	San Diego
Caudell & Johnson (sand and gravel)	Box B, Hillcrest Sta., San Diego 3	Mission Valley, Poway Valley
Crystal Silica Co. (sand and gravel, filter sand)	717 E. 61st St., Los Angeles 1	Oceanside
Daley Corp. (sand and gravel)	Mission Valley & Ward Rd., San Diego 4	San Diego
Denton's Sand Plant, Edmond Denton (sand and gravel)	4166 Pepper Dr., San Diego 5	El Cajon
H. G. Fenton Material Co., Inc. (sand and gravel)	1245 National Ave., San Diego 12	San Diego
Henry Gray (sand and gravel)	609 S. Hill St., Oceanside	Oceanside
Howard & Haskins (sand and gravel)	P.O. Box 81, Santee	Santee
Nelson & Sloan (sand and gravel)	Box 488, Chula Vista	Chula Vista
Carl Niemann (sand and gravel)	Box 52, Del Mar	Rancho Santa Fe
Smith Contractors (sand and gravel)	Box 37, Cardiff	Cardiff
Valley Granite Co., (riprap)	243 E. Fifth St., Escondido	Escondido
Vista Cement Products, A. J. McFall (sand and gravel)	156 W. Vista Way, Vista	Vista
Woodward Sand Co., Arthur C. Woodward (sand and gravel)	2914 Bancroft St., San Diego 4	San Diego
San Joaquin County:		
Frank B. Marks & Sons (sand and gravel)	P.O. Box 668, Newman	Tracy
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Riverbank, Tracy, Kerlinger
Putnam Sand & Gravel Co. (sand and gravel)	P.O. Box 486, Modesto	Riverbank
P. F. Sievers, Mokelumne Pit (sand and gravel)	P.O. Box 24, Clements	Clements
Tracy Rock & Gravel Co. (sand and gravel)	2101 Weber St., Stockton	Tracy
Clyde Wood Co. (sand and gravel)	P.O. Box 599, Lodi	Clements
San Luis Obispo County:		
Guiton Molding Sand Co. (sand and molding sand)	Box 258, Oceano	Oceano
Walter B. Roselip (sand and gravel)	Box 251, San Luis Obispo	Atascadero
San Mateo County:		
A. & B. Quarry (crushed rock-macadam, ballast, rubble, riprap, etc.)	P.O. Box 1037, Redwood City	Woodside
Brisbane Rock Co. (crushed rock-macadam, ballast, rubble, riprap, etc.)	P.O. Box 638, Brisbane	Brisbane
Rockaway Quarry, Inc. (sand)	340 Pine St., San Francisco	Rockaway Beach
California Aggregates (crushed rock)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Ken Royce, Inc. (crushed rock-macadam)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Peter Sorenson (crushed rock-macadam, fill rock)	927 Arguello, Redwood City	Belmont
Santa Barbara County:		
Buell Flat Rock (sand and gravel)	Solvang	Solvang
Southern Pacific Milling Co, (sand and gravel)	735 State St., Santa Barbara	Santa Maria

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Santa Clara County:		
Henry W. Jensen (sand and gravel)	575 Apricot Way, Campbell	Campbell
Los Gatos Sand and Gravel Co. (sand and gravel)	P.O. Box 502, Los Gatos	Los Gatos
George Neary (crushed rock-macadam, fill rock)	Rt. 1, Box 604, Los Altos	Los Altos
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Coyote and Campbell, San Jose
Leo F. Piazza Paving Co. (sand and gravel)	Rt. 1, Box 800, San Jose	San Jose
A. J. Raisch Paving Co. (sand and gravel)	900 W. San Carlos St., San Jose	San Jose
Rhodes & Robinson, Stanford Quarry (crushed rock-macadam, riprap, fill rock)	Box 325, Palo Alto	Palo Alto
A. Voss (sand and gravel)	10445 Stevens Rd., Cupertino	Stevens Creek
Western Gravel Corp. (sand and gravel)	P.O. Box 1026, Campbell	Campbell
Santa Cruz County:		
Henry J. Kaiser Co. (sand)	1924 Broadway, Oakland	Olympia
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Olympia
Santa Cruz Aggregate Co. (sand and gravel)	P.O. Box 485, Felton	Felton and Olympia
Shasta County:		
J. H. Hein Co. (sand and gravel)	P.O. Box 226, Redding	Redding
Oaks Sand, Gravel & Cement Products Co., (sand and gravel, crushed rock)	1737 Yuba St., Redding	Redding
Siskiyou County:		
John S. Jensen & M. N. Thompson (sand and gravel)	Box 836, Mount Shasta	Mount Shasta
Southern Pacific R. R. Co., Chief Engineer (slag and volcanic cinder)	Southern Pacific Bldg., San Francisco	Kegg
Solano County:		
Fredrickson Bros. (crushed rock, fill rock)	1259 65th St., Emeryville	
J. M. Nelson, Cordelia Quarry (crushed rock-macadam, riprap)	Rt. 1, Cordelia	Cordelia
Parish Bros. (crushed rock-macadam, riprap)	Benicia	Benicia
Sonoma County:		
Basalt Rock Co. (sand and gravel, crushed rock, riprap, etc.)	P.O. Box 5401, Eighth and River Sts., Napa	Healdsburg
S. Cabrol (flagstone)	Rt. 1, Box 115, Glen Ellen	Glen Ellen
Gordenker Bros., (flagstone)	R.F.D. Box 112a, Glen Ellen	Glen Ellen
Thomas A. Graham (crushed rock-macadam)	Box 1, Occidental	Occidental
Hein Bros. Basalt Rock Co., Mark Hein, Pres. (crushed rock-macadam, ballast)	P.O. Box 162, Petaluma	Petaluma
Maxwell Bros. (sand and gravel)	1330 King St., Santa Rosa	Santa Rosa

Stanislaus County:		
Greystone Sand Plant (sand and gravel)	316 River Rd., Modesto	Modesto
Hughson Gravel Plant (sand and gravel)	P.O. Box 35, Hughson	Hughson
Johnson Bros. (sand and gravel)	Rt. 1, Box 1880, Modesto	Modesto
Frank B. Marks & Sons (sand and gravel)	P.O. Box 668, Newman	Newman
Modesto Sand and Gravel Co., Inc. (sand and gravel)	Rt. 2, Box 901R, Modesto	Modesto
Putnam Sand & Gravel Co. (sand and gravel)	P.O. Box 486, Modesto	Modesto
C. Skove & J. Wychopen (sand and gravel)	222 Chestnut St., Turlock	Tuolumne River
Standard Rock Co. (sand and gravel)	Escalon	Escalon
H. Sykes (sand and gravel)	P.O. Box 626, Patterson	Patterson
Chas. D. Warner & Son, Inc. (sand and gravel)	1027 Waterford Rd., Modesto	Modesto
W. E. Yeisley (crushed rock)	Box 225, Jamestown	
Tehama County:		
Allen & Reddy (sand and gravel)	Box 729, Red Bluff	Red Bluff
Oaks Sand, Gravel & Cement Products Co. (sand and gravel)	1737 Yuba St., Redding	
Trinity County:		
Northwestern Pacific R. R. Co. (crushed rock, ballast)	San Rafael	Island Mountain
Tulare County:		
Middletons-Sequoia Rock Co. (sand and gravel)	P.O. Box 1468, Visalia	Visalia and Lemon Cove
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Lindsay
Terminus Beach Rock Co. (sand and gravel)	P.O. Box 291, Lemon Cove	Lemon Cove
Tuolumne County:		
Beerman & Jones (sand and gravel, riprap)	P.O. Box 678, Sonora	Soulsbyville
Ventura County:		
Montalvo Rock Co. (sand and gravel)	Box 188, Montalvo	Montalvo
Santa Paula Rock Co. (sand and gravel)	P.O. Box 671, Santa Paula	Santa Paula
Saticoy Rock Co. (sand and gravel, crushed rock-macadam)	Box 970, Ventura	Saticoy-Ventura
Ventura Molding Sand Co., O. D. Messmore (molding sand)	P.O. Box 1808, Ventura	Ventura
Yolo County:		
Leroy Kerr (sand and gravel)	Box 34, Yolo	Yolo
Pacific Coast Aggregates, Inc. (sand and gravel)	400 Alabama St., San Francisco	Yolo
Schwarzgruber & Sons (sand and gravel)	28 W. Main St., Woodland	Cache Creek
J. Dudley Stephens (sand and gravel)	Box 79, Woodland	Esparto
Yuba County:		
Rice Bros. (sand and gravel)	P.O. Box 1489, Marysville	Marysville
Yuba River Sand Co. (sand and gravel)	Box 307, Marysville	Marysville

Nonmetallic Minerals—Continued

Silica

Operator	Address	Location
Kern County:		
N. W. Sweetser (quartz)	Box 445, Rosamond	Rosamond
Mariposa County:		
Kaiser Aluminum & Chemical Corp. (quartz)	Permanente	Le Grande
Monterey County:		
Del Monte Properties (ground silica sand)	Pebble Beach	Pacific Grove
Owens-Illinois Glass Co. (glass sand)	P.O. Box 359, Pacific Grove	Pacific Grove
Riverside County:		
Owens-Illinois Glass Co. (glass sand)	P.O. Box 298, Corona	Corona
San Bernardino County		
Mineral Materials Co., (quartzite) C. W. Dunton, Mgr.	1145 Westminister Ave., Alhambra	Oro Grande

Slate

Operator	Address	Location
El Dorado County:		
Pacific Minerals Co., Ltd. (granules, filler)	337-10th St., Richmond	Chili Bar
Van Ness Brothers	Le Grande	Le Grande

Nonmetallic Minerals—Continued

Soda

Operator	Address	Location
Inyo County:		
Kaiser Aluminum & Chemical Co. (soda ash)	Kaiser Bldg., 1924 Broadway, Oakland	Lone Pine
Natural Soda Products Co., (soda ash, trona)	405 Montgomery St., San Francisco 4	Keeler
Pittsburgh Plate Glass Co., Columbia Chemical Division (soda ash, trona)	Bartlett	Bartlett
San Bernardino County		
American Potash & Chemical Co. (soda ash, salt cake)	3030 W. Sixth Street, Los Angeles 54	Trona
West End Chemical Co., (soda ash)	608 Latham Sq. Bldg., Oakland 12	Westend

Sulfur

Operator	Address	Location
Inyo County:		
Crater Group, R. E. Kitching	310 Pacific St., Bakersfield	Big Pine
Los Angeles County:		
Hancock Chemical Co., (sulfur recovered from petroleum refinery gases)	P.O. Box 810, Long Beach 1	Wilmington

Nonmetallic Minerals—Continued

Talc, Soapstone and Pyrophyllite

Mine	Operator	Address	Location
El Dorado County:			
(soapstone)	Pacific Minerals Co., Ltd.	337 10th St., Richmond	Shingle Springs
Inyo County:			
Longhorn (talc)	W. H. Anderson	Box 733, Big Pine	Eureka Valley
Alberta, Florence, and White Mt. (talc)	Wm. Bonham	Lone Pine	Keeler
Big Talc and Warm Springs (talc)	Louise Grantham et al	1151 Council Ave., Ontario	Big Pine
Eureka (talc)	Ray Harlis	Big Pine	Big Pine
Elnoris (talc)	F. M. Henderson	1568 N. Orange Grove, Pomona	Big Pine
Gold Belt Group (talc)	Roy Hunter	Lone Pine	Gold Belt
Eclipse (talc)	Kennedy Minerals Co., Inc.	2552 E. Olympic Blvd., Los Angeles	Big Pine
Eclipse (talc)	A. E. Nicholls	Darwin	Darwin
Eureka (talc)	James F. Nikolaus	109 S. Main, Big Pine	Big Pine
Gray Eagle (talc)	G. P. Rogers	Box 39, Big Pine	Big Pine
Frisco, Talc City, Trinity, Panamint, Tecopa (talc) Saline, Ubehebe	Sierra Talc & Clay Co.	5509 Randolph St., Los Angeles	Keeler, Shoshone, and Tecopa
Los Angeles County:			
Dr. Katz (soapstone)	Kennedy Minerals Co., Inc.	2552 E. Olympic Blvd., Los Angeles 23	Acton
Mono County:			
(pyrophyllite)	Charles Brown	Laws	Laws
Pacific (pyrophyllite)	Huntley Industrial Minerals Inc.	P.O. Box 305, Bishop	Laws
San Bernardino County:			
Yucca Grove (talc)	Desert Talc & Clay Co.	Pomona	Yucca Grove
Victor (pyrophyllite)	Mineral Materials Co., Ltd.	1145 Westminster Ave., Alhambra	Victorville
Ibex, Monark, Silver Lake (talc)	Sierra Talc & Clay Co.	5509 Randolph St., Los Angeles	Shoshone and Baker
Calmasil, Excelsior, and Superior (talc)	Southern California Minerals Co., W. S. Skeoch	320 S. Mission Rd., Los Angeles	Ivanpah, Shoshone, and Baker
(talc)	Western Talc Co.	1901 E. Slauson Ave., Los Angeles	Tecopa
San Diego County:			
Mathews (pyrophyllite)	Pioneer Pyrophyllite Products	P.O. Box 686, Chula Vista	Del Mar

Metallic Minerals

Antimony

Mine	Operator	Address	Location
Riverside County:			
Mt. Antimony	R. A. Mattey	Box 369, Corona	Corona

Chromite

Mine	Operator	Address	Location
Butte County:			
Lambert	Helmke, Thomas and Janssen	320 Market St., San Francisco	Magalia
Del Norte County:			
Buckskin-Fourth of July	C. H. McClendon	P.O. Box 61, Crescent City	Crescent City
Chrome Hill and Elk Camp	Peter Janzen	Gasquet	Patrick Creek
Elk Creek	L. J. Harper	Patrick Creek Inn, via O'Brien, Ore.	Patrick Creek
Higgins Brass	Ted Webb	P.O. Box 32, O'Brien, Ore.	Patrick Creek
High Plateau	E. R. Brown	O'Brien, Ore.	High Plateau
Holliday	Holliday Mines, Inc.	Box 509, Crescent City	
Low Divide	Harold T. Funk	Rt. 1, Box 782, Crescent City	Low Divide
Tyson	Tyson Mining Co.	P.O. Box 191, Smith River	Smith River
	J. & W. Mining Co.	Gasquet	Gasquet
El Dorado County:			
Pillikin	Allied Mining Co.	Box D, Lincoln	Auburn
Fresno County:			
Thickstun	West Coast Chrome Producers	Box 324, Coalinga	Coalinga

Metallic Minerals—Continued

Chromite—Continued

Mine	Operator	Address	Location
Monterey County:			
South Slope	Holeman & Powell Paving Co.	2980 Allesandro St., Los Angeles 39	Los Burrows
Napa County:			
White Angel	W. B. Shepherd	Box 92, Monticello	Monticello
San Luis Obispo County:			
Hardface	Pierce Bros.	595 Second St., Morro Bay	Morro Bay
Pick and Shovel	San Luis Mining Co.	1185 Monterey St., San Luis Obispo	Chorro Creek
Sweetwater and Norcross	International Metallurgical Chrome Corp.	1026 Chorro St., San Luis Obispo	San Luis Obispo
Santa Clara County:			
O'Connell and Santa Theresa	Palo Alto Mining Co.	599 S. San Tomas Rd., Campbell	San Jose
Shasta County:			
North Star	W. A. Orsini, et al	Box 181, Summit City	La Moine
Siskiyou County:			
Black Bear	L. J. Conley	1270 Orchard Home Dr., Medford, Ore.	Gazelle
Black Hawk	George and McBroom	Cecilville	Cecilville
Black Jack	D. W. Hatcher & W. W. Aseltine	Box 344, Yreka	Trail Gulch
Blue Eagle	S. H. & S. Mining Co.	626 S. W. Sixth St., Grants Pass, Ore.	Seiad
Cyclone Gap	Mrs. Ruth Robertson	P.O. Box 475, Grants Pass, Ore.	Preston Peak
High Divide	Merrick & Holloway	1432 E. Main St., Medford, Ore.	Moffett Creek
Tehama County:			
Sunshine, etc.	Tedoc Mining Co.	Platina	Begum
Trinity County:			
Three B's	E. R. Brewer, and W. R. Cherry	Big Bar	Big Bar

Metallic Minerals—Continued

Copper

Principal copper producers in California in 1951. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location	Rank in State
Amador County:				
Copper Hill	Copper Hill Mine	520 Geary Street, San Francisco	Latrobe	12
Calaveras County:				
Donner	Sierra Copper Company	920 Burchett St., Glendale	Milton	11
Penn	Penn Chemical Co., Inc.	Campo Seco,	Campo Seco	2
Star and Excelsior	Trebor Corp.	410-22nd Street, Merced	Milton	9
Inyo County:				
Darwin Group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin	3
Gold Bottom	Louis Warnken, Jr.	Darwin	Trona	13
Pine Creek	U. S. Vanadium Co.	30 E. 42nd St., New York, N. Y.	Bishop	8
Shoshone Group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa	5
San Bernardino County:				
Bagdad-Chase	Donald F. Love	Box D, Ludlow	Ludlow	4
Shasta County:				
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Bella Vista	1
Bully Hill Smelter Site	M. D. and M. C. Jordan	504 West Park St., Butte, Montana	Bully Hill	10
Hornet—Richmond	Mountain Copper Co., Ltd.	216 Pine St., San Francisco	Matheson	6
Kennett Smelter Cleanings	International Smelting & Refining Co.	818 Kearns Bldg., Salt Lake City, Utah	Coram	7

Metallic Minerals—Continued

Gold

Principal gold producers in California in 1951. (Not less than 100 oz.)

Mine	Type of Mine	Operator	Address	Location
Amador County:				
Kennedy tailings	d	Jackson & Austin Milling Co.	1120-24th Street, Sacramento	Jackson
Old Eureka	a	Central Eureka Mining Co.	2210 Russ Bldg., San Francisco	Sutter Creek
Lorentz group	h	Lorentz and Swingle	Plymouth	Plymouth
Butte County:				
Butte unit	f	Yuba Consolidated Gold Fields	351 California St., San Francisco	Biggs
Dredge No. 3	h	Thurman and Wright	960 Russ Bldg., San Francisco	Chico
Calaveras County:				
Altaville (Alta)	u	Gold Bar Mining Co.	Box 10, Altaville	Altaville
Blackstone	a	Blackstone Mine	5208 Barrett Ave., Richmond	West Point
McCarty	h	Mountain Gold Dredging Co.	Sutter Creek	Valley Springs
Penn	l	Penn Chemical Co., Inc.	Campo Seco	Campo Seco
El Dorado County:				
Cosumnes	a	Cosumnes Mines, Inc.	Grizzly Flats	Grizzly Flats
Grit	a	Liddicoat Gold Mines, Inc.	Route A, Box 27, Greenwood	Greenwood
Hazel Creek	a	Hazel Creek Mining Corp.	463 Main St., Placerville	Sly Park
River Pine dredge	h	River Pine Mining Co., Ltd.	141 Battery St., San Francisco	El Dorado
Shaw	a	Volo Mining Co.	464 Main St., Placerville	Placerville
Fresno County:				
Rockfield	s	Pacific Coast Aggregates, Inc.	400 Alabama St., San Francisco	Friant
Imperial County:				
Cargo Muchacho	a	Holmestake Mining Co.	Box 308, Winterhaven	Ogilby
Inyo County:				
Darwin group	m,d	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin
Gold Bottom	k,d	Louis Warnken, Jr.	Darwin	Trona
Shoshone group	k	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa

Kern County:				
Cactus Queen	a	Burton Mines, Inc.	Rosamond	Mojave
C & H Materials Company	s	C & H Materials Co.	Box 638, Oildale	Oildale
Golden Queen	a	N. W. Sweetser and J. W. Beyer	Rosamond	Mojave
Joe Walker	a	Basin Mining Co.	Box 726, Bakersfield	Piute
Nine Spot	w	E. B. Atkinson	Box 101, Johannesburg	Randsburg
Tropico	a	Burton Bros., Inc.	Rosamond	Willow Spring
Whitmore	c	Red Ink Mining Co.	7214 Sepulveda Blvd., Van Nuys	Mojave
Yellow Aster	a	King Solomon lease	Box 101, Johannesburg	Randsburg
Los Angeles County:				
Newa (Rogers and Gentry)	a	Newa Mining Corp.	3433 W. 64th St., Seattle, Wash.	Neenach
Madera County:				
Howell Bros. dredge	j	Howell Bros.	Box 73, Raymond	Raymond
Mariposa County:				
Dredge No. 3	h	Thurman and Wright	960 Russ Bldg., San Francisco	Hornitos
Merced County:				
Snelling dredge	f	Snelling Gold Dredging Co.	Snelling	Snelling
Mono County:				
Sarita group	a	Sarita Milling Co.	513 Atlas Bldg., Salt Lake City, Utah	Bridgeport
Nevada County:				
Ancho & Erie groups	a	Ancho Erie Mining Co.	401 Second St., San Francisco	Graniteville
Brunswick-Idaho Maryland	a	Idaho Maryland Mines Corp.	Grass Valley	Grass Valley
Eastman (Middle Fork)	i	Crescent Pacific Mining Co.	260 California St., San Francisco	North Bloomfield
Empire Star group	a	Empire Star Mines Co., Ltd.	Grass Valley	Grass Valley
Minona	i	Minona Mining Co.	201 W. Fourth St., Willmar, Minnesota	French Corral
Placer County:				
American Hill	g	W. B. Pendleton	Box 131, Foresthill	American Hill
Mary Len	a	A. H. L. Mining Co.	Box 240, Newcastle	Penryn
Sacramento County:				
Capital dredge	f	Capital Dredging Co.	351 California St., San Francisco	Folsom
Cosumnes dredge	f	Cosumnes Gold Dredging Co.	465 California St., San Francisco	Sloughhouse
Fair Oaks plant	s	Fair Oaks Gravel Co.	4000 Illinois Ave., Fair Oaks	Fair Oaks
General Dredge No. 2	h	General Dredging Co.	Natoma	Natoma
Haggin Sand & Gravel Co.	s	Mrs. C. W. Craig	2457 Portola Way, Sacramento	Brighton
Natomas	f	Natomas Co., et al	Box 1197, Sacramento	Folsom
San Bernardino County:				
Alvord	a	Roy V. Waughtel	Box 411, Yermo	Yermo
Bagdad-Chase	r	Donald F. Love	Box D, Ludlow	Ludlow
Rambler-Hilltop	a	Frank Czerwonka	Box 121, Lucerne Valley	Lucerne Valley

Metallic Minerals—Continued

Gold—Continued

Mine	Type of Mine	Operator	Address	Location
San Joaquin County:				
Lower Camanche dredge	f	Gold Hill Dredging Co.	311 California St., San Francisco	Camanche
Shasta County:				
Afterthought	l	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Bella Vista
Battams	h	Roy S. Olson	1178 Walnut St., Redding	Redding
Kennett Smelter cleanings	v	International Smelting and Refining Co.	818 Kearns Bldg., Salt Lake City, Utah	Coram
Thurman dredge	f	Thurman Gold Dredging Co.	960 Russ Bldg., San Francisco	Redding
Sierra County:				
Brush Creek	a	Best Mines Company	Box 177, Downieville	Goodyear Bar
Kate Hardy	a	John O'Donnell	Alleghany	Alleghany
Original Sixteen to One	a	Original Sixteen to One Mine, Inc.	235 Montgomery St., San Francisco	Alleghany
Red Star (Yellow Jacket)	a	Yellow Jacket Consolidated Gold Mines	120 Chester Ave., Bakersfield	Alleghany
Siskiyou County:				
Siskiyou unit	f	Yuba Consolidated Gold Fields	351 California St., San Francisco	Callahan
Stanislaus County:				
La Grange dredge No. 4	f	La Grange Gold Dredging Co.	1805 Mills Tower, San Francisco	La Grange
Trinity County:				
Bennett	g	Bennett Mining Co.	Big Bar	Big Bar
Coffee Creek	f	Alcan Mining Co.	5261 Stockton Blvd., Sacramento	Coffee
Fairview Placers	f	Fairview Placers	Lewiston	Minersville
La Grange	f	Oregon Gulch Dredging Co.	Fort Jones	Weaverville
Yuba County:				
Browns Valley group	a	Empire Star Mines Co., Ltd.	Grass Valley	Browns Valley
Yuba unit	f	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton

LEGEND

a—lode gold mine
c—gold-silver mine
d—tailings dump
f—dredge (bucket-line)
g—hydraulic mine
h—dragline
i—dryland dredge
j—suction dredge
k—lead mine
l—zinc mine
m—zinc-lead mine
r—copper mine
s—commercial gravel plant
u—drift mine
v—flue dust and slag
w—drywashing

Metallic Minerals—Continued

Iron

Mine	Operator	Address	Location
Riverside County:			
Eagle Mountain	Kaiser Co., Inc.	Box 217, Fontana	Desert Center
San Bernardino County:			
Bessemer	Transhippers, Inc.	963 Mills Bldg., San Francisco	Newberry

Metallic Minerals—Continued

Lead

Principal lead producers in California in 1951. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location	Rank in State
Calaveras County:				
Penn	Penn Chemical Co., Inc.	Campo Seco	Campo Seco	11
El Dorado County:				
Hazel Creek	Hazel Creek Mining Corp.	463 Main St., Placerville	Sly Park	19
Inyo County:				
Darwin group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin	1
Defense	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Panamint Springs	5
Empress	Len C. Martin	Darwin	Darwin	20
Gold Bottom	Louis Warnken, Jr.	Darwin	Trona	9
Keeler tailings	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Keeler	16
Lippincott (Lead King)	Lippincott Lead Mines	Box 1811, Santa Ana	Scotty's Castle	6
Minnietta	Finley and Vignich	Panamint Springs via Lone Pine	Panamint Springs	7
Queen of the Mountains	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Keeler	21
Shoshone group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa	2
Surprise	A. L. Foss	Panamint Springs via Lone Pine	Panamint Springs	15
Swansea tailings	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Keeler	12
Ubehebe Lead	W. V. Skinner	625 Muir Ave., Lone Pine	Scotty's Castle	10
Riverside County:				
Bald Eagle	Dan Figueroa & Sons	Rt. 1, Box 8, Blythe	Midlands	14
San Bernardino County:				
Carbonate King	Carbonate King Mines	481 Church St., San Bernardino	Nipton	13
Kelly	Edward Koppleman	4457 Simpson Ave., North Hollywood	Nipton	17
Mohawk	Mohawk Mines, Inc.	Nipton	Nipton	8
Sagamore	Claremont Mining Co.	336 W. Second St., Claremont	Ivanpah	18
Shasta County:				
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Bella Vista	3
Kennett Smelter Cleanings	International Smelting and Refining Co.	818 Kearns Bldg., Salt Lake City, Utah	Coram	4

Metallic Minerals—Continued

Magnesium Metal

Operator	Address	Location of plant
Kaiser Magnesium Co.	Box 671, Manteca	Manteca

Mercury (Quicksilver)

Mine	Operator	Address	Location
Contra Costa County:			
Mt. Diablo	Mt. Diablo Mine, Ronnie Smith, Trustee	2106 Tower Petroleum Bldg., Dallas, Tex.	Clayton
Del Norte County:			
Webb (Patrick Creek)	David L. Webb	O'Brien, Ore.	Patrick Creek
Fresno County:			
Archer	Archer Mining Co., Inc.	510 S. Spring St., Los Angeles	Coalinga
Lake County:			
Abbott	California Quicksilver Mines, Inc.	Williams	Wilbur Springs
Mirabel	A. Garcia	Middletown	Middletown
Napa County:			
James Creek Placers	A. & J. Garcia, T. Marino, and J. Kinsela	Middletown	James Creek
Knoxville	Glenn A. Truitt	Geyser Rd., Cloverdale	Knoxville
Oat Hill Placer	L. D. Reeder and Paul Piner	Middletown	Aetna Springs
San Benito County:			
Aurora	Reyes Diaz & Juan Carrillo	Box 21, Idria	Idria
El Rey	C. C. Friend and J. Quinonez	235 Second St., Hollister	Panoche
Juniper	Louis Schichetti	Box 637, Hollister	Panoche
Live Oak	James Tobar	Panoche via Paicines	Panoche
New Idria and San Carlos	New Idria Mining & Chemical Co.	Idria	Idria
North Star	Leonard W. Knepper	Box 98, Idria	Idria
Tirado	Joe Tirado	San Benito	Hernandez
Valley View	Larry Rios	Panoche via Paicines	Panoche
Wonder	Paul Gonzales	1499 Ford Ave., San Jose	Panoche

Metallic Minerals—Continued

Mercury (Quicksilver)—Continued

Mine	Operator	Address	Location
San Luis Obispo County:			
Rinconada	Geo. P. Bell	Santa Margarita, Box 37A	Santa Margarita
Santa Clara County:			
----	Ed Cooper	Santa Clara	----
Guadalupe	Arthur S. Burrell	Rt. 3, Box 835, Los Gatos	Almaden
New Almaden Dump	H. F. Austin	Almaden	Almaden
New Almaden Dump	A. W. McFarland	Los Gatos	Almaden
New Almaden Dump	Frank B. Pfeiffer	Almaden	Almaden
Sonoma County:			
Culver Baer	C. A. Baumeister & Sons	Cloverdale	Cloverdale
Dewey-Buckman	Buckman Laboratories, Inc.	Geyser Rd., Cloverdale	Cloverdale
Ella B. Eureka	Vincent C. Harrison	Rt. 1, Box 28X, Windsor	Pine Flat
Mt. Jackson	Sonoma Quicksilver Mines, Inc.	593 Market St., San Francisco	Guerneville

Molybdenum

Mine	Operator	Address	Location
Inyo County:			
Pine Creek	U. S. Vanadium Co.	30 E. 42d St., New York 17, N. Y.	Bishop

Metallic Minerals—Continued

Silver

Principal silver producers in California in 1951. (Not less than 1,000 oz.)

Mine	Type of mine	Operator	Address	Location	Rank in state
Amador County:					
Old Eureka	a	Central Eureka Mining Co.	2210 Russ Bldg., San Francisco	Sutter Creek	19
Calaveras County:					
Penn	l	Penn Chemical Co., Inc.	Campo Seco	Campo Seco	4
Inyo County:					
Darwin group	m, d	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin	1
Defense	k	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Panamint Springs	5
Gold Bottom	k, d	Louis Warnken, Jr.	Darwin	Trona	17
Keeler tailings	d	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Keeler	25
Lee (Silver Reid)	l	Chas. E. Lurcott, Jr.	Darwin	Keeler	16
Lippincott (Lead King)	k	Lippincott Lead Mines	Box 1811, Santa Ana	Scotty's Castle	14
Minnietta	k	Finley & Vignich	Panamint Springs via Lone Pine	Panamint Springs	11
Pine Creek	p	U. S. Vanadium Co.	30 E. 42d St., New York, N. Y.	Bishop	12
Shoshone group	k	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa	2
Surprise	k	A. L. Foss	Panamint Springs via Lone Pine	Panamint Springs	24
Swansea tailings	d	L. D. Foreman & Co.	1354 Second Ave., Salt Lake City, Utah	Keeler	22
Ubehebe Lead	k	W. V. Skinner	625 Muir Ave., Lone Pine	Scotty's Castle	29
Kern County:					
Cactus Queen	a	Burton Mines, Inc.	Rosamond	Mojave	28
Golden Queen	a	N. W. Sweetser and J. W. Beyer	Rosamond	Mojave	10
Tropico	a	Burton Mines, Inc.	Rosamond	Willow Spring	23
Wegman group	b	Margaret Wegman	Box 195, Randsburg	Mojave	15
Whitmore	c	Red Ink Mining Co.	7214 Sepulveda Blvd., Van Nuys	Mojave	8
Mono County:					
Sarita group	a	Sarita Mill Co.	513 Atlas Bldg., Salt Lake City, Utah	Bridgeport	30
Nevada County:					
Brunswick-Idaho Maryland	a	Idaho Maryland Mines Corp.	Grass Valley	Grass Valley	7
Empire Star group	a	Empire Star Mines Co., Ltd.	Grass Valley	Grass Valley	6

Metallic Minerals—Continued

Silver—Continued

Mine	Type of mine	Operator	Address	Location	Rank in state
Riverside County:					
Bald Eagle	k	Dan Figueroa & Sons	Rt. 1, Box 8, Blythe	Midland	31
Sacramento County:					
Natomas	f	Natomas Company	Box 1197, Sacramento	Folsom	20
San Bernardino County:					
Bagdad-Chase	r	Donald F. Love	Box D, Ludlow	Ludlow	18
Mohawk	k	Mohawk Mines, Inc.	Nipton	Nipton	13
Shasta County:					
Afterthought	l	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Bella Vista	3
Bully Hill Smelter Site	v	M. D. and M. C. Jordan	504 W. Park St., Butte, Mont.	Bully Hill	33
Hornet-Richmond	n	Mountain Copper Co., Ltd.	216 Pine St., San Francisco	Matheson	32
Kennett Smelter Cleanings	v	International Smelting and Refining Co.	818 Kearns Bldg., Salt Lake City, Utah	Coram	9
Sierra County:					
Brush Creek	a	Best Mines Co.	Box 177, Downieville	Goodyear Bar	27
Original Sixteen to One	a	Original Sixteen to One Mine, Inc.	235 Montgomery St., San Francisco	Alleghany	26
Yuba County:					
Yuba unit	f	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton	21

LEGEND

a—lode gold mine
b—silver mine
c—gold-silver mine
d—tailings dump
f—dredge (bucket-line)
k—lead mine

l—zinc mine
m—zinc-lead mine
n—pyrite mine
p—tungsten mine
r—copper mine
v—flue dust and slag

Metallic Minerals—Continued

Titanium (ilmenite)

Operator	Address	Location of deposit
Los Angeles County:		
Thos. J. Wright and Walter Johnstone	100 E. Colorado Blvd., Pasadena	Hermosa Beach

Tungsten

Mine	Operator	Address	Location
Alpine County:			
Alpine	Alpine Mining Co.	P.O. Box 114, Gardnerville, Nev.	Markleeville
Fresno County:			
Garnet	Qualls, Qualls, and Prather	Tollhouse	Dinkey Creek
Garnet Dike	Garnet Dyke Mine	c/o Kings River Hatchery, Fresno	Kings River
Inyo County:			
Brownstone	Brownstone Mining Co.	P.O. Box 983, Pasadena	
Black Monster	Joe Brackett	Box 562, Bishop	Bishop
Ghoring	J. S. Wildom	Oasis	Oasis
Hanging Valley and Je M	Tungstar Hanging Valley Mining Co.	6253 Hollywood Blvd., Hollywood	Bishop
High Noon	R. S. Dahl	Death Valley	Furnace Creek
Jimmie Linda	E. McWhorter	Rt. 1, Bishop	Bishop
Kilroy	A. A. Goehring	Oasis via Big Pine	Oasis
L. & L.	Lester Brown	Box 674, Bishop	Bishop
Mac B. and Iva	Meddles and Brainer	Lone Pine	Darwin
Moonlite	John L. Peters	P.O. Box 593, Bishop	Bishop
Pine Creek	U. S. Vanadium Co.	30 E. 42d St., New York, N. Y.	Bishop
Round Valley	Pinnacles Tungsten Co.	5658 Wilshire Blvd., Los Angeles	Bishop
Rossi	Frank G. Phillips	380 Clarke St., Bishop	Bishop
Santa Claus	Ray Harvey	Box 132, Bishop	Bishop
Scheelite Hope	Hedgcock and Lasley	Bishop	Bishop
Target	Lyle Donahue	Oasis via Big Pine	Deep Springs
Tip Top	F. J. Penny	508 Howard St., Bishop	Big Pine

Metallic Minerals—Continued

Tungsten—Continued

Mine	Operator	Address	Location
Inyo County—Continued			
Tip Top	Walter Thomas	Box 100, Big Pine	Big Pine
Tungsten City	E. Lovelace	Bishop	Bishop
Tungsten Hill	Sterling Carter	Mercer Cave, Murphys	Bishop
Valley-Coyote	Ray and L. B. McMurray	175 N. Main St., Bishop	Bishop
White Mountain	V. W. Elderd and R. Skaggs	Rt. 1, Box 19, Bishop	Bishop
----------	California Tungsten Mining and Milling Co.	1905 Riverside Dr., Chino	Furnace Creek
Kern County:			
Ada R.	L. C. Bills	3814 Chestnut Ave., Long Beach	Randsburg
Barbara Diana	Stryker and Herrel	Box 264, Johannesburg	Randsburg
Blue Bird	L. J. Sain	Box 342, Randsburg	Randsburg
Borawa	Borawa Mines, Inc.	211½ S. Olive Ave., Alhambra	Randsburg
Easter	Kutzner & Chas. Fluheart	Box 628, Tehachapi	Bodfish
Butte	John S. Hitchcock	Glennville	Glennville
Lucy Guy	Geo. Ritchie	Box 2023, Mojave	Mojave
Snow White No. 1	R. A. Edwards	Inyokern	Indian Wells
Tejon	R. W. Copeland	152 Moffett Dr., Bishop	Isabella
Tungsten King	Wm. J. B. Stewart and Steve Ling	Bodfish	Bodfish
Tungsten Hill	Johnson and Seward	Box 22, Bodfish	Havilah
Tungsten V	C. L. Seager and W. Hilton	Box 712, Oildale	Havilah
Weldon Meadow	B. Blonder	Box 35A, Kernville	Weldon
----------	Weidenbenner and Corbridge	Randsburg	Red Mountain
Madera County:			
Strawberry	Strawberry Tungsten Mines, Inc.	1739 Terrace Ave., Fresno	Clover Meadow
Mono County:			
Hilton Creek	Blue Ridge Midway Gold Mines, Co., Inc.	Box 478, Bishop	----------
Mohawk	David McConnell	Laws	----------
Whitehorse	Whitehorse Mining Corp.	935 E. Scott St., Stockton	Coleville
San Bernardino County:			
Atolia	Surcease Mining Co.	214 30th St., Sacramento 16	Atolia
Bright Outlook	Harry F. Heather	236 S. Oak Knoll Ave., Pasadena	Baker
Clipper Mountain	Pinnacle Tungsten Co.	5658 Wilshire Blvd., Los Angeles	Essex
Cole and Swift	Cole and Swift	Randsburg	Atolia

Craig and Celestial	Harvey F. Vice	Box 97, Barstow	Barstow
Hidden Value	Hidden Value Tungsten Co., L. J. Roucheau	2700 Budlong Ave., Los Angeles	Danby
Mary Ann	Adelanto Mining Co., Inc.	Adelanto	Adelanto
Section 9	Walter H. Zindell	Box 71, Essex	Essex
Shining Star	Alan Kissock and Co.	70 Pine St., New York, N. Y.	Victorville
Shooting Star	Shooting Star Tungsten Co.	5615 W. Pico, Los Angeles	Bear Lake
Star Bright	Minerals Materials Co.	1145 Westminster Ave., Alhambra	Barstow
Tamana	V. T. Bowald	Randsburg	Atolia
White Dollar	Parker Mining and Milling Co.	Box 202, Barstow	Daggett
Tulare County:			
Big Jim	Tulare County Tungsten Mines	Box 361, Lindsay	Three Rivers
Harrell Hill	Consolidated Tungsten Mines	1739 Terrace Ave., Fresno	Orosi
Sherman Peak	Sherman Peak Mining Co.	P.O. Box 583, Kernville	

Zinc

Principal zinc producers in California in 1951. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location	Rank in State
Calaveras County:				
Penn	Penn Chemical Co., Inc.	Campo Seco	Campo Seco	3
Inyo County:				
Darwin group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin	1
Lee (Silver Reid)	Chas. E. Lurcott, Jr.	Darwin	Keeler	8
Shoshone group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa	4
San Bernardino County:				
Carbonate King	Carbonate King Mines	481 Church St., San Bernardino	Nipton	7
Carbonate King Zinc	J. Q. Little	Nipton	Nipton	6
Shasta County:				
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Bella Vista	2
Kennett Smelter Cleanings	International Smelting & Refining Co.	818 Kearns Bldg., Salt Lake City, Utah	Coram	5

List of Smelters and Mineral Dealers Reporting Purchase of California Metals Produced in 1951

Name	Address	Location of plant	Metals reported purchased
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Amarillo, Tex.	Zinc
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	El Paso, Tex.	Copper, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Garfield, Utah	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Hayden, Ariz.	Copper, gold, silver
American Smelting & Ref. Co.	405 Montgomery St., San Francisco	Selby	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Tacoma, Wash.	Copper, lead, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N. Y.	Anaconda, Mont.	Copper, lead, zinc, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N. Y.	Great Falls, Mont.	Zinc
Bethlehem Pacific Coast Steel Corporation	20th and Illinois Sts., San Francisco	San Francisco	Iron ore
Bradley & Ekstrom	320 Market St., San Francisco	San Francisco	Manganese, chromite, iron ore
Bradley Mining Co.	Crocker Bldg., San Francisco	Stibnite, Idaho	Antimony
Braun Corporation	2260 E. 15th St., Los Angeles	Los Angeles	Quicksilver
Coast Chemical Division F. W. Berk & Co., Inc.	Sharon Bldg., San Francisco	San Francisco	Quicksilver
Columbia-Geneva Steel Division, U. S. Steel Co.	P.O. Box 269, Salt Lake City, Utah	Geneva, Utah	Manganese and iron ores
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Miami, Ariz.	Copper, gold, silver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Tooele, Utah	Copper, lead, zinc, gold, silver
Kaiser Co., Inc.	P.O. Box 217, Fontana	Fontana	Iron ore, manganese ore, chromite
Kennecott Copper Corp.	120 Broadway, New York, N. Y.	McGill, Nev.	Copper, gold, silver
Lippincott Lead mines	Box 1811, Santa Ana	Santa Ana	Lead and zinc ore
Mefford Chemical Co.	1026 Sante Fe, Los Angeles	Los Angeles	Quicksilver
Pacific Vegetable Oil Co., Bernard T. Rocca	62 Townsend St., San Francisco	San Francisco	Quicksilver
Phelps-Dodge Corp.	40 Wall St., New York, N. Y.	Ajo, Ariz.	Copper, gold, silver
Quicksilver Producers Ass'n., Irving Ballard, Sec'y.	407 Sansome St., San Francisco	San Francisco	Quicksilver
Sullivan Mining Co.	Wallace, Idaho	Silver King, Idaho	Zinc
Twining Laboratories	2527 Fresno St., Fresno	Fresno	Tungsten ore
U. S. Mint	Duboce & Market Sts., San Francisco	San Francisco	Gold, silver
U. S. Smelting, Refining & Mining Co.	Newhouse Bldg., Salt Lake City, Utah	Midvale, Utah	Copper, lead, zinc, gold, silver
United States Vanadium Corp.	30 E. 42d St., New York, N. Y.	Bishop	Tungsten ore
Western Gold & Platinum Works	589 Bryant St., San Francisco	San Francisco	Platinum, gold, silver*
Wildberg Bros. Smelting & Ref. Co.	742 Market St., San Francisco	San Francisco	Platinum, gold, silver*

* Gold and silver in special high-grade ores only.

DIRECTORY OF MINERAL DEALERS AND COMMERCIAL LABORATORIES

List of Mineral Dealers, Custom Mills, and Commercial Grinding Plants in California

Firm	Remarks
American Minerals Co., 840 Mission Rd., Los Angeles.	Commercial grinding of minerals.
Atkins, Kroll & Co., 320 California St., San Francisco 4.	Dealer in tungsten ores, mercury, gypsum and limerock.
Baroid Sales Division National Lead Co., 830 Ducommun St., Los Angeles	Talc and other soft non-metallic minerals ground by contract or purchased.
Bishop Concentrate & Cleaning Co., Bishop.	Custom mill; purchases tungsten ores and base metal ores.
Blood, Harry E., Co., 5028 Alhambra Ave., Los Angeles	Dealer in industrial sand and silica products.
Bradley & Ekstrom, 320 Market St., San Francisco 11	Dealer in all commercial minerals.
Brumley-Donaldson Co., 557 Howard St., San Francisco 5, and 3050 E. Slauson Ave., Huntington Park	Dealer in sand, clay, limestone, dolomite, and other minerals.
Burton Bros., Rosamond, Kern County	Custom cyanide mill. Gold and silver ores purchased.
Butte Lode Mining Co., Randsburg	Custom amalgamation mill, gold-silver ore.
Castle Crags Chrome Co., Box 126X, Castella	Dealer in or custom milling of chrome ores.
Commercial Minerals Co., 310 Irwin St., San Francisco 7	Commercial grinding by contract or minerals purchased.
Dailey Chemical Laboratories, Box 228, Oroville	Custom mill for black sands.
Empire Star Mines Co., Ltd., Grass Valley	Amalgamation, flotation and cyanide mill; gold ore and concentrates purchased.
Hidecker Co., 800 S. Mission Rd., Los Angeles	Clay grinding plant; non-metallic minerals ground by contract or purchased.
Hill Bros. Chemical Co., 2159 Bay St., Los Angeles	Grinding asbestos, and custom milling of small lots of soft non-metallic minerals.
Huntley Industrial Minerals, P.O. Box 305, Bishop	Dealer in talc, pyrophyllite, garnet sands, clay and mica.
Industrial Minerals & Chemical Co., 836 Gilman St., Berkeley	Non-metallic minerals ground by contract or purchased.
Kennedy Minerals Co., 2552 E. Olympic Blvd., Los Angeles	Non-metallic minerals ground by contract or purchased.
Los Angeles Chemical Co., 1960 S. Santa Fe Ave., Los Angeles	Dealer in non-metallic minerals.
Metals Disintegrating Co., Inc. 1069 Second St., Berkeley 10	Non-metallic mineral grinding by contract or purchase.
Mojave Mining & Milling Co., Martin Beck, Mojave	Custom mill, amalgamation and flotation.
Ontario Rock Milling Co., 7557 E. Olive, Paramount	Non-metallic minerals ground by contract or purchased. Roofing granules prepared.
Sierra Talc & Clay Co., 5509 Randolph St., Los Angeles 22	Dealer in talc and clays.
Southern California Minerals Co., 320 S. Mission Rd., Los Angeles	Dealer in talc, clay and other minerals.
Twining Laboratories, 2527 Fresno St., Fresno	Purchase and concentrate tungsten ores on a custom basis, also commercial grinding.
U. S. Vanadium Co., Bishop	Tungsten mill, ore purchased.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles	Non-metallic mineral grinding plant; minerals ground by contract or purchased.

List of Commercial Assay and Testing Laboratories

San Francisco Area

Firm	Services
American Spectrographic Laboratories, 557 Minna St., San Francisco	Spectrographic analysis of minerals and water by quantitative methods. Radioactivity measurements.
Ball, C. M., 911 University Ave., Berkeley 2	Fire assay, chemical analysis of ores and minerals.
Curtis & Thompkins, Ltd., 236 Front St., San Francisco 11	Chemical analysis and specification testing of metallic ores, metals, and non-metallic minerals.
Hall Laboratories, Inc., 200 Davis St., San Francisco 11	Consulting water chemists.
Hanks, Abbot A., Inc., 624 Sacramento St., San Francisco 11	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests, spectrographic analysis, water analysis.
Hersey Inspection Bureau, 3405 Piedmont Ave., Oakland	Engineers, chemists, and testers of building materials, foundations.
Hunt, Robert W., Co., 251 Kearny St., San Francisco 8	Fire assay, analysis of ceramic materials, analysis of ores and minerals, spectrographic analysis, water analysis.
Krebs, Kellogg, 564 Market St., San Francisco 4	Ore dressing, mineral beneficiation.
Metallurgical Laboratories, 604 Mission St., San Francisco 5	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, spectrographic analysis, water analysis.
Multiphase, Inc., 351 Eighth St., San Francisco 3	Spectrographic analysis.
Pacific Chemical Laboratories, 617 Montgomery St., San Francisco 11	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis, spectrographic analysis, water analysis.
Peninsula Laboratories, 544 S. San Antonia Rd., P.O. Box 372, Los Altos	Chemical analysis of ores, minerals, and metals; ore and mineral beneficiation, chemical and metallurgical research.
Pittsburg Testing Laboratories, 651 Howard St., San Francisco 5	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis, water analysis.
Western Gold and Platinum Works, 589 Bryant St., San Francisco 7	Fire assay, chemical analysis of ores and minerals, ore dressing beneficiation.
Western Machinery Co., 760 Folsom St., San Francisco 7	Ore dressing, mineral beneficiation, coal washing, sand preparation.
Wildberg Bros. Smelting & Refining Co., 742 Market St., San Francisco 2	Fire assay and chemical analysis.

Los Angeles Area

Firm	Services
California Testing Laboratories, Inc., 619 E. Washington, Los Angeles 15	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests.
Dorr Co., 811 W. Seventh St., Los Angeles 14	Ore dressing, mineral beneficiation.
Eisenauer, Ed., Jr., 322 S. San Pedro St., Los Angeles	Fire assay, chemical analysis of ores and minerals.
Herr, A. V., 5176 Hollywood Blvd., Los Angeles	Fire assay, chemical analysis of ores and minerals.
Hollywood Testing Laboratories, 1257 N. La Brea Ave., Hollywood 38	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing beneficiation, petrographic analysis, physical tests, spectrographic analysis, water analysis, X-ray diffraction.
Hunt, Robert W., Co., 6353 Miles Ave., Huntington Park	Chemical analysis of ores and minerals.
Keldon Research Corporation, Box 2555, Terminal Annex, Los Angeles 54	Chemical analysis of ores and minerals; chemical analysis of ceramics; spectrographic analysis, water analysis.
Kennard & Drake, 3364 E. 14th St., Los Angeles 23	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis.
Los Angeles Testing Laboratory, 1300 S. Los Angeles St., Los Angeles 15	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis.
Meco Assayers, 417 S. Hill St., Los Angeles 13	Fire assay, chemical analysis of ores and minerals.
Metal Control Laboratories, 2735 E. Slauson Ave., Huntington Park	Chemical analysis of ores, minerals and metals, physical tests, spectrographic analysis and metallurgical examinations.
O. M. Miles, Jr., 9500 S. Norwalk Blvd., Los Nietos	Ceramic testing and engineering.
Minerals Engineering, 417 S. Hill St., Los Angeles 13	Ore dressing, beneficiation of ores and minerals.
The National Supply Co., 1524 Border Ave., Torrance	Chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests.

List of Commercial Assay and Testing Laboratories—Continued

Los Angeles Area—Continued

Firm	Services
Osborne, Raymond G. Laboratories, 110 W. Ninth St., Los Angeles 15	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical testing of construction materials.
Sill, Harley A., 1011 S. Figueroa St., Los Angeles 15	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis.
Smith-Emery Co., 781 E. Washington Blvd., Los Angeles 12	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, spectrographic analysis.
Southwestern Engineering Co., 4800 S. Santa Fe Ave., Los Angeles	Ore dressing, beneficiation of minerals.
Triplett & Barton, Inc., 831 N. Lake St., Burbank	Chemical analysis of ores and minerals, spectrographic analysis (rare earth analyses), X-ray diffraction metallography.
Truesdail Laboratories, Inc., 4101 N. Figueroa, Los Angeles 65	Chemical analysis of ores and minerals physical testing of ferrous and non-ferrous metals and alloys.
von Huene, Rudolph, 865 N. Mentor Ave., Pasadena 6	Thin and polished sections.
Ward, S. Paul, Inc., 605 Mission St., South Pasadena	Ceramic testing.

Other Areas

Bishop Assay Office, 381 N. Main St., Bishop	Fire assay; chemical analysis of ores, minerals, and tungsten ores; testing laboratory.
Calaveras Assay Office, P.O. Box 645, Angels Camp	Fire assay, chemical analysis of ores and minerals, milling tests.
Clarkson Chemical Laboratories, 1550 Sixth Ave., San Diego	Fire assay, chemical and spectrographic analysis of ores and minerals.
Dailey Chemical Laboratory, Box 228, Oroville	Black sand assay.
Martin C. Engel, Cantil	Fire assay; chemical analysis of ores and minerals.
Grant, Ernest V., 26 Broadway, Jackson	Fire assay, chemical analysis of ores and minerals, mill test.
Hornkohl Laboratories, 716 Truxton Ave., Bakersfield	Fire assay, chemical analysis of ores and minerals, analysis of oil cores, oils, muds, water, industrial hazards.
Morse Laboratories, 316 16th St., Sacramento	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic, analysis, chemical and mining engineers.
Mountain States Uranium Corp., P.O. Box 929, Bishop	Fire assay; chemical analysis of ores and minerals, analysis of raw ceramic materials; analysis of tungsten ores; water analysis.
Nevada City Assay & Refining Office, E. J. N. Ott, 130 Main St., Nevada City	Fire assay, chemical analysis of ores and minerals, mill tests.
Peninsula Laboratories, 544 S. San Antonio Rd., P.O. Box 372, Los Altos	Chemical analysis of ores and minerals, ore dressing and beneficiation, analysis of petroleum and oil analysis.
Rombough, M. D., 3069 Del Paso Blvd., North Sacramento	Fire assay, chemical analysis of ores and minerals, mill tests.
San Joaquin Research Laboratory, 2253 S. McKinley Ave., Box 1987, Stockton	Fire assay, chemical analysis of ores and minerals.
Scheave, Harold, 237 Commercial St., Nevada City	Fire assay, chemical analysis of ores and minerals.
Twining Laboratories, 2527 Fresno St., Box 1472, Fresno	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, petrographic analysis, physical tests, spectrographic analysis, water analysis, X-ray diffraction.
Valley Analytical & Testing Laboratories, Inc. P.O. Box 642, El Centro	Chemical analysis of ores, minerals, and water.

The Division of Mines laboratory provides free identification of rocks and minerals, based on physical, chemical, and optical examination for residents of California. Quantitative analyses, both chemical and spectrographic, and assays for the metals can be obtained from commercial chemists and assayers specializing in this work. For gold and silver determinations, please patronize commercial assayers.

MINES AND MINERAL RESOURCES OF AMADOR COUNTY, CALIFORNIA

By Denton W. Carlson * and William B. Clark *

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* Junior Mining Geologist, California Division of Mines. Manuscript submitted for publication January 1953.

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ABSTRACT

Amador County, 598 square miles in extent, lies largely in the Sierra Nevada. The crest of the Sierra Nevada, which, in Amador County, attains an altitude of 9,371 feet, is in the eastern part, while the western part borders the alluvial plain of the San Joaquin Valley.

The bedrock of the Sierra Nevada consists of steeply dipping, isoclinally folded and faulted metamorphic rocks which have been invaded by several types of igneous rocks. Overlying the bedrock are nearly flat-lying Tertiary sediments and volcanic rocks. The pre-Tertiary rocks are composed of Carboniferous, Permian, and Jurassic metasediments and volcanics and late Jurassic igneous rocks, chiefly granodiorite. The Tertiary rocks are Eocene sands, clays, and auriferous gravels and Miocene and Pliocene volcanic rocks.

The chief industries of Amador County are logging, agriculture, and mining. Since 1880 more than $165,500,000 worth of mineral products has been produced. The single commodity responsible for nearly 85 percent of this total is gold, most of which has been produced from that part of the Mother Lode gold belt between Jackson and Plymouth. Actually, this segment has been the richest part of the entire 115-mile length of the lode. Other important mineral products are clay, coal (lignite), and copper.

The largest producers of gold have been the Kennedy, Argonaut, Keystone, and Plymouth mines, all of which have been inactive for nearly a decade. The Central Eureka mine which is now active is one of the few Mother Lode gold mines which survived the government restriction order L-208 of 1942 and increased mining costs. Other past important gold producers have been the Fremont-Gover, Lincoln, Zeila, Oneida, Original Amador, South Eureka, Wildman, Mahoney, Treasure, and Bunker Hill mines. In the east belt the Belden, Rainbow, and Pioneer Lucky Strike mines were important producers. Several small east belt mines are now active. Substantial quantities of gold have been produced by gold dredges, hydraulic mines, drift mines, and by the re-working of old tailings. Several small dragline dredges are now active near Volcano.

Clay is produced chiefly from Eocene beds in the western part of the county. The chief clay producers are Gladding McBean and Company, Western Refractories Company, and the Pacific Clay Products Company. Coal is now produced in the Buena Vista area by the American Lignite Products Company and the Humacid Company. Two mines, the Newton and Copper Hill, have produced most of the copper in Amador County.

Other mineral products of Amador County are silver, chrome, manganese, iron ore, asbestos, sand and gravel, crushed rock, limestone and marble.

INTRODUCTION

Amador County is an irregular-shaped area lying between the Mokelumne River on the south and the Cosumnes River on the north. It

extends from Alpine County on the east to Sacramento and San Joaquin Counties on the west. Originally part of Calaveras County, Amador County was created on May 11, 1854. It was named for Jose Maria Amador, son of Sergeant Pedro Amador, a Spanish soldier who settled in California in 1771.

The first authentic report of the presence of white men in Amador County was in 1846, when Captain John Sutter, accompanied by a small party of Indians and a few white men, conducted logging operations on the ridge between Sutter and Amador Creeks. A few months after the discovery of gold 45 miles to the north in 1848 prospectors began to swarm into what is now Amador County. By 1851 towns such as Drytown, Fiddletown, Jackson, and Volcano had been established.

Geography

Amador County embraces an area of 598 square miles. Altitude varies from 200 feet in the western part of the county to 9,371 feet, the altitude of Mokelumne Peak, in the east. The central area averages about 4,000 feet.

In 1950 the population of Amador County was 9,151. Jackson, the county seat, is the largest town, with a population of 1,879. Other important towns are: Ione, 1,071, Sutter Creek, 1,151, Plymouth, 382, and Amador City, 151. The county is served by the Ione branch of the Southern Pacific railroad and the Amador Central railroad which connects with the Southern Pacific at Ione and extends to Martell. State Highway 49 runs north-south across the central portion of the western end. State Highway 88 extends the length of the county in a general east-west direction.

In the western foothills the climate is hot during the summer and mild during the winter. The central portion has a moderate climate but the most mountainous eastern portion has heavy snows in the winter. Rainfall averages 30 inches in the western portion and 43 inches in the eastern portion.

Amador County is drained by the Mokelumne River in the southern part of the county and the Cosumnes River along the northern margin. Other important streams are Jackson, Sutter, Rancheria, and Dry Creeks. Although the drainage pattern is partly controlled by the north to northwesterly trend of the major geologic structures, the main rivers and streams flow in a general southwesterly direction.

Industries

Logging, agriculture, and mining are the principal industries of Amador County. Logging operators cut trees in 1950 worth $9,000,000. The value of agricultural products in 1950, primarily livestock, amounted to $3,100,000. Mining operations, the third most important industry of Amador County, produced mineral products worth $1,026,560 in 1950. Hydroelectric power plants on the Mokelumne River are operated by the Pacific Gas and Electric Company.

GEOLOGY

Amador County lies almost entirely in the Sierra Nevada geomorphic province; only the extreme western portion lies in the Great Valley. From the Great Valley eastward, the range gradually rises to the gla-

FIGURE 1. Logtown Ridge formation, showing jointing in porphyritic andesite exposed in road cut 4 miles east of Ione.

ciated crest in the vicinity of Mokelumne and Thimble Peaks, both of which lie above 9000 feet.

The older rocks of the Sierra Nevada, commonly called the "Bedrock series," consist of isoclinally folded, complexly faulted metamorphic rocks of Paleozoic and Mesozoic ages, intruded by several types of igneous rocks, chiefly granitic. Unconformably overlying these rocks in the western portion of Amador County are much younger, nearly flat-lying Tertiary sediments. These nearly flat-lying sediments are commonly called "Superjacent series."

In Amador County, the older metamorphic rocks are divided into the Calaveras and Amador (Taliaferro, 1943, pp. 282-284) groups and Mariposa formation. The Calaveras group includes all of the pre-Mesozoic rocks in this county while the Amador group and Mariposa formation are Jurassic. Taliaferro has divided the Amador group of Amador County into two distinctive formations: the Cosumnes and Logtown Ridge.

Rock Formations

Calaveras Group (Carboniferous and Permian in Part). The Calaveras group is an undifferentiated suite of rocks ranging mainly from Carboniferous to Permian; part of the series may be older than the Carboniferous. In this region, it consists predominantly of highly contorted, poorly bedded, blackish-gray, recrystallized cherts and quartzites. Present in smaller amounts are greenstones, low-grade carbonaceous slates, mica schist, and grayish-colored recrystallized limestones which in rare cases contain crinoid and coral debris. These rocks most commonly strike north-northwest with a high angle of dip to the east.

Amador Group (Middle to Upper Jurassic). The lowest formation of the Amador group, the Cosumnes, lies unconformably on the Calaveras.[1] Sheared sands, grits, slates, and a thick basal conglomerate containing pebbles and boulders of chert, quartz, schist, and volcanic rocks in a sandy or gritty matrix characterize the Cosumnes. Some of the sheared sands have been completely metamorphosed to mica and sericite schists.

The Logtown Ridge formation is composed of massive porphyritic augite andesite with a coarse andesite agglomerate at the base. The andesite commonly has a fine-grained groundmass and contains coarse phenocrysts of brownish-black augite. The agglomerate occurs as thick beds and contains angular fragments of andesite, quartz, chert, and schist. Interbedded in smaller amounts are welded tuff, tuffaceous sandstone, and slate.

Mariposa Formation (Upper Jurassic). A conspicuous formation, the Mariposa consists of extensive beds of dark slates with small amounts of phyllite and schist and a thick, coarse basal conglomerate. The slates are bluish- to black-gray in color and crop out extensively as nearly vertical beds in Amador County. Small cross-bedded sand lenses are common in these slates. The coarse basal conglomerate contains pebbles and cobbles of chert, quartz, volcanic rocks, and schist.

Ione Formation (Middle Eocene). The Ione, which is middle Eocene in age, occurs on the low rolling hills of western Amador County in nearly flat-lying beds. It consists essentially of soft, friable white sand with scattered grains of mica and interbedded lenses of white clays and lignite. Also occuring in the Ione are the gold-bearing Eocene stream gravels composed of pebbles and boulders of quartz, chert, granites, and volcanic rocks.

Valley Springs Formation (Middle (?) Miocene). The Valley Springs formation as mapped by Piper, Gale, et al., (1939, pp. 71-80) is composed predominantly of fragmental and rhyolitic detritus of Miocene age. This formation is composed of rhyolite tuff, breccia, conglomerate, and siltstone with a sandstone member at the base. It occurs west of and in the vicinity of Buena Vista Peak in the southwestern part of the county.

Mehrten Formation (Upper (?) Miocene and Pliocene (?)). The Mehrten formation, which unconformably overlies the Valley Springs formation, consists largely of volcanic debris laid down by the Mio-

[1] Taliaferro, N. L., personal communication, 1949.

FIGURE 2. Roadcut exposing Mehrten formation on Jackson-Ione road.

Pliocene inter-volcanic river systems. This formation, which was named and mapped by Piper, Gale, et al., (1939, pp. 61-71,) is composed chiefly of boulders and fragments of porphyritic andesite with smaller amounts of siltstone, sandstone, clay, and conglomerate.

Recent Alluvium. Recent alluvium consists of sand, silt, and gravel in and adjacent to the present stream channels.

Intrusive Rocks

During late Jurassic time the crust beneath Amador County was intruded by granitic rocks of the Sierra Nevada batholith. This batholith, which is predominantly granodiorite, also included other rocks, such as granite, quartz monzonite, gabbro, feldspar and quartz porphyries, diorite, and pegmatite. Much of the basic rock has since been altered to serpentine. The weathered products from these intrusive igneous rocks constituted a major part of detritus that built the later Tertiary formations.

Geologic History

The oldest rocks found in Amador County are those of the Calaveras group which were deposited as marine sediments late in the Paleozoic era approximately 230 to 255 millions of years ago. These sediments were deposited as mud, sand, and marl which have since been changed into the different metamorphic rock types of the Calaveras group. Also associated with these rocks and with the submarine volcanic products of that time are chemically deposited manganese-bearing, siliceous sediments. During the Paleozoic a vast open sea covered what is now Amador County. At or near the end of the Paleozoic a crustal disturbance took place which resulted in at least partial destruction of the sea basin and creation of a mountain chain of unknown extent.

Between the end of the Paleozoic era and the middle of the Jurassic period the sea again advanced over what is now Amador County. Near the end of the middle Jurassic period, sediments (Cosumnes member of the Amador group) were deposited at the bottom of this Mesozoic sea to the extent of many thousands of feet. Marine sedimentation was followed by submarine volcanism, the products of which contributed to the Logtown Ridge member of the Amador group. Subsequent marine deposition gave rise to what is now termed the Mariposa formation. Associated with the accumulation of the Jurassic submarine volcanics are manganese deposits of limited size. These were laid down on the sea floor as chemically deposited sediment derived by precipitation from volcanic hot-spring water.

In late Jurassic time, orogenic processes began to elevate a new Sierra Nevada. This effected an almost complete withdrawal of the ancient sea from what is now the Sierra Nevada area. The nearly flat-lying Mesozoic sedimentary beds were folded into a complicated series of folds trending for the most part northwest, while the sediments themselves were being changed into metamorphic rocks. The ancestral Sierra Nevada of late Jurassic time was thus created as a fold-mountain range. Prior to destruction of the Jurassic sea-basin, igneous rocks of peridotite composition were intruded into the marine sediments as sills and irregular massive intrusions. Introduced with these peridotite rocks, now altered to serpentines, were segregations and disseminated patches of chromite.

Toward the end of the period of folding which elevated the ancestral Sierra Nevada, granitic rocks were introduced into the folded crust on a major scale, followed by hydrothermal deposition deep within the folded crust of gold, copper, and zinc. A very long period of weathering and erosion followed the elevation of the Jurassic Sierra Nevada with its attendant emplacement of granitic rocks and gold quartz veins. For twenty or thirty million years erosion stripped away the rocks lying above the gold deposits and cut deeply into the gold-bearing veins themselves. The elevations of the Jurassic Sierra Nevada were greatly reduced and broad river valleys developed. Thus the stage was set for the important and complicated series of events of the Tertiary which governed the character and location of the placer gold deposits destined to play such an important part in the human history of California.

Just before the opening of the Tertiary period, the Upper Cretaceous sea advanced east across a narrow belt of the ancestral Sierra Nevada marginal to the present Great Valley. Thin, relatively flat-lying fossiliferous marine deposits were laid down on the folded, eroded bedrock surface and patches of these old deposits are still found from place to place along the western edge of the present Sierra Nevada. In Amador County, however, Cretaceous deposits so far have not been found and were either removed by erosion or else were never deposited.

By Eocene time, the opening epoch of the Tertiary, the ancestral Sierra Nevada had been greatly worn down and the climate had changed from the temperate one of the Jurassic to subtropical. With the reduced elevations and the warm humid climate, chemical decay of the bedrock proceeded slowly but deeply. The finer products of this decay, chiefly clay and quartz sand, were removed by running water and deposited along the margins of the Eocene sea, giving rise to valuable clay and quartz sand deposits. This sea lapped onto the flanks of the

SUMMARY OF ECONOMIC GEOLOGY OF AMADOR COUNTY

Geologic age		Formations	Distribution	Rock types	Mineral deposits
QUATERNARY		Alluvium	Stream channels, terraces	Sand, silt, gravel	Placer gold, sand and gravel
TERTIARY	Pliocene	Mehrten	Patches on hills in western and central portion	Flow andesite, andesitic conglomerate, silt, sand, clay	Potential source of stone
TERTIARY	Miocene	Valley Springs	Patches in southwest portion	Rhyolite tuff, breccia	Potential source of building stone
TERTIARY	Eocene	Ione	Extensive beds in western portion of Amador County	Clay, sand, gravel	Clay, lignite, sand, gravel, placer gold, dimension stone, impure iron ore
MESOZOIC	Jurassic	Veins	Mother Lode, East Belt, and Foothill Belt	Vein quartz	Gold, silver, copper, lead, zinc
MESOZOIC	Jurassic	Granitic rocks	Extensive bodies cropping out in eastern and central portions of Amador County	Granodiorite, other intrusive rocks	Potential source of building stone and aggregate
MESOZOIC	Jurassic	Serpentine	¼-to-½ mile-wide discontinuous belt trending NNW, between Ione and Highway 49	Serpentine altered from ultrabasic igneous rocks	Chromite, ornamental stone
MESOZOIC	Jurassic	Mariposa	Two NW-trending mile-wide belts; one along Mother Lode, the other 5 to 6 miles west of Mother Lode	Slate, metaconglomerate, and residual clay	Building slate, clay
MESOZOIC	Jurassic, Amador group	Logtown Ridge	NW-trending belts west of Mother Lode 100-500 feet wide	Meta-andesite, agglomerate tuff, and residual clay (lateritic)	Building stone, aggregate, clay (lateritic)
MESOZOIC	Jurassic, Amador group	Cosumnes	NW-trending belts west of Mother lode 100-500 feet wide	Metamorphosed sand, silt, slate, conglomerate	
PALEOZOIC	Permian, Carboniferous	Calaveras group	Extensive NW-trending belts west and east of Mother Lode	Metachert, quartzite, greenstone, limestone, slate	Marble, limestone, manganese; potential source of other varieties of building stone

FIGURE 3. Glaciated granitic surface at east shore of Silver Lake.

ancestral Sierra Nevada in much the same fashion as had the Upper Cretaceous sea before it. An interfingering of Eocene river and marginal marine deposits resulted. The coarser, heavier materials, notably gold and quartz pebbles from the veins, resistant to decay and to abrasion, were left behind and became concentrated in the stream channels as placer deposits. These Eocene placer deposits were unusually rich and were characterized by an abundance of white quartz pebbles and a paucity of fresh volcanic debris. They were confined to channels worn into bedrock and in most places were overlain by white rhyolite ash, or pipe clay as it was called.

At or near the close of the Eocene epoch, volcanism which broke out in the Sierra Nevada was destined to have a profound effect upon the economic geology of the placer gold deposits. It began with falls of white rhyolite ash low down in the Sierra Nevada and with both flows and ash falls higher in the range. So much volcanic ash fell that it choked the stream channels and completely changed the drainage system of the Sierra Nevada. River gravels and placer deposits developing along water courses cut after the initial volcanism tended to be much leaner in gold and were characterized by an abundance of rhyolite pebbles. By late Miocene or early Pliocene time volcanic activity reached its peak with emission of massive flows of gray andesite as well as large volumes of fragmental material, the latter frequently giving rise to extensive mud flows. These volcanic products deeply buried the Eocene channel deposits and Miocene intervolcanic channel deposits alike, in many places to depths of several hundred feet. Channel deposits developing during or after the emission of andesite were still leaner in gold and commonly were not of economic value at all. Burial of Eocene gold placers by volcanic debris and by the later extruded latite and

basalt flows did, however, serve to protect in some measure the placers from obliteration by later erosion.

The abundant semi-tropical flora which flourished along the margin of the Sierra Nevada contributed sufficient vegetal material to the swamp and marginal marine deposits to give rise to valuable beds of lignite now being exploited for natural waxes. These lignite deposits tend to be associated with other valuable deposits of clay and white quartz sand.

In the late Pliocene and early Pleistocene, major re-elevation of the Sierras by faulting took place, probably accompanied by violent earthquakes. Snow and ice packs on the peaks began to build up and migrate down the slopes as glaciers, elaborately carving the highland topography. Pleistocene glaciers occupied the northeastern tip of Amador County to a little south of Silver Lake, and just crossed into the southeast corner of the county.

Continued stripping of gold lodes in Pleistocene and Recent times enriched the present stream channels with placer gold. The glaciers retreated from Amador County and the Sierras in the early Recent epoch, and the present climate and topography developed.

METALLIC MINERALS

Chromite

Chromite deposits occur as magmatic segregations in ultrabasic igneous rocks or in serpentine derived from ultrabasic rocks. A north-northwest trending belt of serpentine ranging from $\frac{1}{4}$ to $\frac{1}{2}$ mile in width crops out discontinuously in western Amador County, particularly in the Ione area.

Most of the chromite deposits of Amador County occur as pods or irregular lenses associated with serpentine or serpentinized dunite. Some of the ore occurs as clots or bunches of disseminated low-grade chromite.

Minor amounts of chromite were produced in Amador County during World War I and some was produced in 1909. Since World War I, the mines of this county have been inactive. For more detailed information on chromite in Amador County, consult California Division of Mines' Bulletin 134 (Cater, 1948).

Copper

A recorded total of nearly eight million pounds of copper has been produced in Amador County since 1880. Prior to 1880, substantial amounts of copper were produced in this county during the state's first copper boom in the Civil War days of the early 1860's.

Irregular and almost continuous production of copper in Amador County began in 1895 and continued until the end of World War I. Most of the small amount of copper recovered between World Wars I and II was a by-product of gold mining; but World War II stimulated the county's industry. More than two million pounds of copper was produced during 1946, the peak year. Since 1947, only minor amounts of copper have been recovered.

Two mines are responsible for the largest portion of the total production of copper, the Copper Hill mine and the Newton mine. Bulletin 144, "Copper in California" (Jenkins, 1948a, pp. 214-216), contains a list of copper properties in Amador County.

During 1942-45 the U. S. Geological Survey and the U. S. Bureau of Mines, as part of the strategic minerals program, mapped and diamond-drilled some of the copper properties in this county.

A belt of rocks containing copper- and zinc-bearing minerals trends north to northwestward across the width of Amador County in the foothills west of the Mother Lode. Within this belt are lenticular sulfide bodies formed by replacement of wall rocks along the zones of shearing, crushing, and faulting in the Amador and Calaveras groups of rocks. Ore bodies are composed predominantly of pyrite and chalcopyrite with smaller amounts of sphalerite, bornite, chalcocite, tetrahedrite, galena, pyrrhotite, gold, and silver. In a few of these deposits sphalerite is a major ore mineral. Ore deposition was controlled primarily by structure and like the gold mineralization was genetically related to the emplacement of the granitic batholith.

Further details concerning Amador County copper may be found in California Division of Mines Bulletin 144 (Heyl, 1948, pp. 15-19).

Copper Hill Mine. Location: SE $\frac{1}{4}$ sec. 34, T. 8. N., R. 9 E., M.D.M., about $2\frac{1}{2}$ miles northwest of Four Corners. Ownership: W. F. Detert Estate, 1715 Mills Tower, San Francisco, California.

The first mining operations at the Copper Hill mine began in 1860-61 and the mine was in operation for over twenty years (Aubury, 1905, p. 186). Large amounts of copper ore and matte were shipped to be refined in Europe. The mine was re-opened by the late W. F. Detert shortly after 1902 and was shut down in 1911, according to Mr. Victor Bonnefoy.

Some work was done during 1943 in the Jackass shaft by J. P. Donovan of San Francisco but there is no recorded production from the mine for that year.

In April, 1948, this mine was again reopened by Victor Bonnefoy of Pine Grove and Clarence Miller of Petaluma who jointly leased the property. The mine is now leased by Miller and sub-leased to Ralph E. Fitzgerald and associates of Jamestown.

The ore consists of chalcopyrite and sphalerite with smaller amounts of chalcocite, bornite, pyrite, malachite, and azurite in a sheared and brecciated zone in Logtown Ridge metavolcanic rocks which strikes northwest and dips 60° northeast. A large cross-faulted zone, also heavily mineralized, cuts the vein at an acute angle, has a northwest strike and dips about 60° to the northeast. In 1943, the U. S. Bureau of Mines diamond-drilled this property. One drill hole northeast of the Jackass shaft encountered an ore body containing 22.37 percent zinc, 0.43 percent copper, 9.31 ounces of silver, and 0.02 ounce of gold.[2]

Three main inclined shafts which dip 60° to 70° northeast are on the property in addition to many smaller shafts and prospect holes. The mine was worked rather extensively during the early 1900's through the Main (700-foot) shaft. About 450 feet southeast of the Main shaft is the Hobo (450-foot) shaft and 900 feet north of the Main shaft is the Jackass (125-foot) shaft. Six levels off the Main shaft include extensive drifting, crosscutting, and stoping. The mine has about 5200 feet of underground workings.

At the present time, two men, including Roy Brown, mine superintendent, are surveying and reopening the Jackass shaft.

[2] West belt copper-zinc mines, Amador and Calaveras Counties, California: U. S. Bureau of Mines War Minerals Rept. 103, p. 8, 1943.

MINERAL PRODUCTION OF AMADOR COUNTY, 1880-1950

Year	Gold, value	Silver, value	Coal		Copper		Pottery clay		Lime		Marble		Brick		Miscellaneous and unapportioned		
			Tons	Value	Pounds	Value	Tons	Value	Barrels	Value	Cu. ft.	Value	M	Value	Amount	Value	Substance
1880	$1,495,053	$1,953															
1881	1,450,000	1,500															
1882	1,500,000																
1883	1,590,000																
1884	2,000,000	2,000															
1885	2,145,591	3,700															
1886	1,874,062	6,136															
1887	1,979,956	2,069															
1888	1,750,000	3,500	24,404	$36,606													
1889	1,560,975	6,398	30,000	45,000													
1890	1,459,952	9,357															
1891	1,395,962	13,895	21,323	31,984													
1892	1,210,383	8,008															
1893	1,505,973	5,230															
1894	1,331,916	280	15,280	23,020			2,500	$3,000			25,941	$35,826					
1895	1,391,929	1,089	21,323	31,985	16,500	$1,650	9,960	10,285			4,864	6,566					
1896	1,523,351	3,767	19,775	29,662	30,000	3,000	8,413	27,825			4,389	5,415					
1897	1,324,472	3,477	20,000	25,000			3,492	9,540			3,864	6,280					
1898	1,806,363	1,742	18,500	29,550	3,000	300	7,197	8,297			2,850	3,594					
1899	1,544,868	6,902	18,500	23,125			10,700	10,900			4,582	7,925					
1900	1,373,788	14,915	27,477	41,215	220,000	34,100	11,500	9,100			4,103	5,891				$318,422	Unapportioned, 1900-1909.
1901	1,823,827	7,444	25,000	30,000	52,000	8,190	10,050	7,100			2,945	4,630	600	$7,000			
1902	1,629,151	2,686	5,450	10,912	130,000	14,620	12,723	13,728			6,300	8,016					
1903	1,609,744	4,336			10,000	900	22,000	19,460			3,074	5,379					
1904	2,060,574	4,055			14,000	1,400	20,608	10,770	1,700	$1,700	4,785	6,558					
1905	2,445,815	17,930			10,000	1,560	21,775	20,000	1,000	1,500	2,703	3,950				750	Glass sand.
1906	2,260,373	14,579			8,648	1,669	26,789	28,119	1,000	1,200	Totals						
1907	2,116,182	13,515			5,300	1,020	12,465	13,992									
1908	1,876,175	13,239			53,940	3,440	23,322	25,369	800	960	[1]70,400	$100,030	2109	61,369	1,000 tons 10 tons 1,072 lbs.	1,200 1,000 40	Limestone. Asbestos. Lead.
1909	2,298,785	16,701			288,472	36,641	33,563	32,724	1,200	1,440	Miscellaneous stone, value		1429	28,572	1,000 tons 2 tons 41 tons	1,375 200 332	Limestone. Asbestos. Chromite.
1910	2,646,246	20,916			151,484	14,386	39,446	49,339	1,400	1,680			2000	30,000	1,000 tons 10,100 tons 11,200 cu.ft.	1,500 10,100 5,600	Limestone. Quartz sand. Sandstone.
1911	2,832,395	28,899			227,848	28,481	43,352	37,359	1,200	1,500			2000	20,000	600 tons 90,000 cu. ft.	6,000 45,000	Soapstone. Sandstone.
1912	2,796,194	32,037			175,608	28,975	35,100	36,856	800	1,040			2500	25,000	6,000 cu. ft. 700 tons	3,000 2,100	Sandstone. Soapstone.

1913	2,901,898	18,097	----	----	19,023	2,949	39,678	38,653	1,000	1,200	670	2000	30,000	2,500 cu. ft.	2,500	Sandstone.
														350 tons	2,420	Soapstone.
														1,960 tons	3,556	Quartz.
														877 tons	670	Glass sand.
														----	11,237	Other minerals.
1914	3,082,002	17,032	5,700	10,062	5,251	694	32,223	33,114	1,540	2,008	----	2500	50,000	16,888 tons	9,855	Glass sand.
														44 lbs.	2	Lead.
														6,250 tons	2,400	Quartz.
														3,960 cu. ft.	1,500	Sandstone.
														610 tons	2,440	Soapstone.
1915	3,894,125	20,409	----	----	4,185	732	40,156	38,879	1,000	1,200	1,300	4000	80,000	523 lbs.	25	Lead.
														13,339 tons	16,142	Silica.
														----	10,950	Other minerals.
1916	3,660,550	18,705	[1]	----	12,349	3,038	29,246	31,106	[1]	----	1,300	[1] and tile	----	300 tons	3,700	Chromite.
														4,341 tons	12,802	Silica.
														495 tons	2,475	Soapstone.
														----	77,752	Brick, coal, lime, manganese, sandstone.
1917	3,664,164	21,358	[1]	----	19,352	5,283	28,970	28,625	----	----	1,200	----	95,345	65 tons	1,420	Chromite.
														4,771 tons	20,766	Silica.
														----	13,033	Coal, lead, manganese, platinum, soapstone, zinc.
1918	3,249,385	29,590	[1]	----	[1]	----	13,562	34,346	----	----	6,500	----	[1]	88 tons	4,400	Chromite.
														13,747 tons	61,724	Silica.
														----	66,695	Brick, coal, copper, manganese, mineral paint, platinum, soapstone.
1919	2,920,492	33,254	[1]	----	----	----	[1]	----	----	----	----	----	[1]	----	142,523	Clay and clay products.
														8,440 tons	67,366	Silica.
														----	9,953	Coal, manganese, platinum, sandstone, soapstone.
1920	1,788.793	19,780	[1]	----	----	----	25,719	61,808	----	----	680	----	[1]	6,116 tons	36,432	Silica.
														----	102,707	Brick, coal, mineral paint, platinum, soapstone.
1921	2,167,443	35,460	----	----	----	----	22,124	46,664	----	----	1,125	----	[1]	1,802 tons	20,646	Silica.
														----	97,126	Brick and platinum.
1922	2,241,100	32,287	----	----	----	----	39,572	68,126	----	----	7,300	----	----	865 tons	5,030	Silica.
														----	125,220	Other minerals.[3]
1923	1,734,133	15,153	----	----	----	----	45,887	58,196	----	----	28,515	----	----	----	119,877	Other minerals.[4]
1924	2,706,508	18,251	[1]	----	[1]	----	64,317	87,444	----	----	3,050	----	----	----	123,612	Other minerals.[5]
1925	2,338,101	16,123	[1]	----	[1]	----	63,889	95,946	----	----	31,100	----	----	----	11,003	Other minerals.[6]

MINERAL PRODUCTION OF AMADOR COUNTY, 1880-1950—Continued

Year	Gold, value	Silver, value	Coal		Copper		Pottery clay		Lime		Miscellaneous stone	Brick		Miscellaneous and unapportioned		
			Tons	Value	Pounds	Value	Tons	Value	Barrels	Value	Value	M	Value	Amount	Value	Substance
														----	237,792	Brick and clay (pottery).[6]
1926	2,167,275	13,422	[1]	----	[1]	----	----	----	----	----	24,900	[1]	----	1,267 lbs.	101	Lead.
														----	8,010	Other minerals.[6]
1927	1,922,714	11,319	[1]	----	[1]	----	118,636	165,210	[1]	----	10,400	[1]	----	2,491 lbs.	157	Lead.
														----	97,998	Other minerals.[7]
1928	2,236,922	14,317	[1]	----	1,402	202	96,209	116,000	----	----	189,900	----	[1]	----	86,838	Brick, coal.
1929	1,601,861	9,392	[1]	----	[1]	----	60,487	88,846	----	----	696,500	----	[1]	----	101,618	Brick, coal, copper, lead, marble.
1930	1,840,191	7,100	[1]	----	[1]	----	74,023	103,160	----	----	388,129	----	[1]	----	86,107	Brick, coal, copper, lead, marble, platinum.
1931	1,549,073	4,783	[1]	----	[1]	----	32,275	57,751	----	----	491,456	----		----	67,933	Brick, coal, copper, lead, marble.
1932	1,307,760	3,865	[1]	----	1,454	92	20,284	26,373	----	----	19,626	----	[1]	2,981 lbs.	89	Lead.
														----	42,481	Brick, coal, marble.
														----	1,178	Lead.
1933	1,945,261	6,471	[1]	----	13,922	891	18,341	26,016	----	----	----	----	[1]	31,845 lbs.	48,781	Brick, coal, marble, misc. stone.
														----	223	Lead.
1934	2,274,275	10,544	[1]	----	7,254	580	28,620	50,833	----	----	12,115	----	[1]	6,102 lbs.	51,591	Brick, coal, gems (diamonds).
1935	2,614,235	17,634	[1]	----	9,641	800	37,876	66,654	----	----	17,066	----	[1]	3,271 lbs.	800	Lead.
														----	48,779	Coal, brick.
1936	3,402,350	18,096	[1]	----	31,542	2,902	52,813	91,228	----	----	30,777	----	----	4,296 lbs.	197	Lead.
														----	71,899	Brick, coal.
1937	3,712,835	18,041	[1]	----	18,579	2,248	66,397	107,212	----	----	[1]	----	----	7,004 lbs.	413	Lead.
														----	77,177	Brick, coal, platinum, misc. stone.
1938	3,724,840	14,569	[1]	----	5,152	505	42,679	73,422	----	----	6,027	----	----	----	61,081	Brick, coal, lead, volcanic ash.
1939	4,167,030	15,411	----	----	3,933	409	37,780	64,147	----	----	3,300	----	----	----	64,276	Brick, lead, platinum, volcanic ash.
1940	4,122,160	16,413	----	----	20,643	2,333	34,282	67,164	----	----	28,769	----	----	11,459 lbs.	573	Lead.
														----	47,447	Brick, platinum, volcanic ash.
1941	3,499,300	16,551	----	----	11,941	1,409	70,645	130,997	----	----	6,088	----	----	13,396 lbs.	764	Lead.
														----	69,303	Brick, slate, volcanic ash.
1942	1,731,590	7,887	----	[1]	1,854	224	119,596	254,771	----	----	17,322	----	[1]	10,559 lbs.	708	Lead.
														----	79,538	Brick, coal, manganese ore, platinum.

1943	91,210	1,607	----	----	624,336	81,164	105,815	236,396	----		26,426	----	1	1,429 lbs.	107	Lead.
														----	97,188	Brick, manganese ore, soapstone.
1944	25,690	1,524	----	1	440,962	59,530	----	1	----		8,492	----	1	1,560 lbs.	125	Lead.
														----	187,845	Other minerals.[10]
1945	16,660	8,901	----	----	1,619,793	218,672	----	1	----		1	----	1	----	243,311	Other minerals.[11]
1946	92,330	12,626	----	----	2,041,536	330,729	90,416	194,061	----		3,963	----	1	----	118,755	Brick, lead.
1947	165,340	10,496	----	----	1,674,000	351,540	198,264	380,496	----		1	----	----	----	5,317	Other minerals.[12]
1948	231,490	2,038	----	----	----	----	189,884	625,537	----		1	----	----	34,490 tons	65,476	Sand and gravel.
														----	16,585	Pumicite and stone.
1949	672,770	3,812	3,900	39,000	300	59	84,286	160,061	----		1	----	----	100 lbs.	29,087	Other minerals,[12] lead.
1950	700,490	3,845	----	1	----	----	110,595	292,125	----		1	----	----	----	30,100	Other minerals.[13]
Totals	$141,774,401	$818,418	256,632	$407,121	7,985,204	$1,247,317	2,490,501	$4,375,130	12,640	$15,428	[1]$1,963,966	----	[1]$427,286	----	$3,734,326	

[1] See under "Unapportioned."
[2] Includes crushed-rock, rubble, rip-rap, sand and gravel.
[3] Includes brick and platinum.
[4] Includes brick and soapstone.
[5] Includes brick, coal, copper and lead.
[6] Includes coal, copper, lead and marble.
[7] Includes brick, coal, copper and silica.
[8] Brick, coal, manganese ore, platinum.
[9] Brick, manganese, soapstone.
[10] Brick, clay (pottery), coal, manganese ore, soapstone.
[11] Brick, clay (pottery), lead, limestone, miscellaneous stone.
[12] Pumice, sand and gravel, and stone.
[13] Coal (lignite), sand and gravel, and stone.

Newton Mine. Location: SW $\frac{1}{4}$ sec. 28, T. 6 N., R. 10 E., M.D.M., $3\frac{1}{2}$ miles east of Ione on state highway 104.

The Newton mine was located early in 1863 (Jenkins, 1948a, p. 50) during the state's first copper boom, and was worked extensively until the mine was shut down in 1867. The mine was worked intermittently after that date and in 1889 a smelter was constructed. Some of the matte produced at the smelter was shipped as far as Liverpool, England. Production during this period ceased in 1901. As of 1908 total recorded production was 33,000 tons (Aubury, 1908, pp. 50, 224).

The mine was reopened by J. H. Lester early in 1943 and production began in May of that year. The Winston Copper Company took it over and operated it from July 24, 1943, to the end of 1944. From about January, 1945, to the time of closing, August 1, 1947, the mine was operated under contract by the Pacific Mining Company.

The ore is a replacement deposit consisting of a typically massive and fine-grained mixture of pyrite and chalcopyrite. The strike is north-northwest and the dip is from 62° to 70° east, parallel to the schistosity of the amphibole-chlorite schist (Logtown Ridge member) in which it occurs. The vein is from 3 feet to a maximum of 8 feet wide, but generally not over 6 feet. The tenor of the ore probably averages close to 6 percent copper (Heyl and Eric, 1948, p. 55). A series of post-mineral cross faults were encountered by mining operations. One of these on the 700-foot level 15 feet from the station faulted the vein 6 feet eastward. Diamond drill holes run by the U. S. Bureau of Mines indicated that ore extends at least 150 feet further down-dip below the 700 level (Heyl and Eric, 1948, p. 60). Ore reserves in 1943 were estimated by the U. S. Bureau of Mines to be 40,300 tons of 4.5 percent of copper ore.[3]

The mine has been worked on 11 levels from a 700-foot inclined shaft. There are approximately 3,000 feet of underground drifts in addition to many stopes and some crosscuts. The bulk of the mining has been done on and above the 550 level. All the equipment used by Pacific Mining Company was removed from the property in August, 1949.

Production and shipment of ore began in May, 1943, and by the end of the year 50 carloads averaging 60 tons each and running from 8 to 10 percent copper[4] had been shipped to Utah. Total mine production to the end of 1946 is 5,461,132 pounds of copper (Heyl and Eric, 1948, p. 51). The mine has been idle since August 1, 1947.

Gold

Amador County's total recorded production of gold from 1880 to 1950 is $141,774,401 and represents the output from many mines, principally on the Mother Lode, but some on the East Belt. This is about 85 percent of the total mineral production so far recorded for the county. As many of the mines along the Mother Lode were in operation prior to 1880 before production was recorded, that segment of the Lode which passes through Amador County probably has produced gold far in excess of $160,000,000 (Bowen and Crippen, 1948, p. 62).

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[3] West belt copper-zinc mines, Amador and Calaveras counties, California. U. S. Bur. Mines War Minerals Rept. 103, p. 6, 1943.

[4] Averill, C. V., Unpublished report, December 2, 1943.

From 1837 until 1932, one ounce of gold was worth a fixed price of $20.67. During the depression years of 1932-33, gold was revalued several times at progressively higher values. The average price during this period was $25.56 per ounce. In 1934 it was revalued to its present price of $35.00 per ounce.

Near the beginning of World War II, the War Production Board, a federal agency, issued Order L-208 which went into effect during the fall of 1942. This war-time law restricting gold mining resulted in the closing of nearly all the major gold mines in the country, including those in Amador County.

The Central Eureka mine is the most important active gold mine in the county and is among the few Mother Lode mines which have survived war-time limitations on gold mining and the increased cost of mining operations.

Placer mining has worked most of the gravels of the county. The last of the large bucketline-dredges, operated by the American Dredging Company, ceased operations on the Mokelumne River in the Lancha Plana area in 1923, after having been in continuous operation for 19 years. Smaller placer mining operations have been active intermittently in this county. Volcano was the center for most of the hydraulic mining which took place in the county.

Gold Mineralization. Lode-gold deposits of Amador County are found principally in the Mother Lode vein system or in the East Belt group of veins. The Mother Lode is traceable through the Sierran foothills for approximately 120 miles from the vicinity of Mariposa northwest to Georgetown, El Dorado County. The vein system or vein zone ranges from less than a hundred feet to more than a mile wide. Within this zone are numerous discontinuous or linked veins which may be parallel, convergent at a small angle, or slightly en echelon. Few individual veins can be traced for more than a few thousand feet along the strike but the vein system as a whole is remarkably persistent.

In general, the Mother Lode veins formed in fissures developed within a zone of reverse faulting that strikes north or northwest over much of its length. Repeated movements along the fault fissures facilitated passage of a succession of ascending mineral-bearing solutions which are believed to have had their source in the crystallizing molten rock that formed the granitic core of the Sierra Nevada. Vein matter consists most commonly of milky quartz in which native gold and simple sulfides occur sporadically in shoots, separated by valueless material. In addition to quartz, the most abundant vein mineral, vein matter commonly consists of carbonates, mariposite, chlorite, sericite and sheared wall rock. Native gold occurs alone in various gangue minerals or with sulfides such as galena, sphalerite, arsenopyrite, tetrahedrite, pyrrhotite, and chalcopyrite. Ore shoots generally are short laterally but persist in depth; they tend to pitch steeply either north or south in veins that trend north or northwest and dip steeply east (Knopf, 1929, p. 26). Veins may pinch or swell abruptly and vein ends commonly fray out into veinlets or stringers. Both hanging and footwall sides of the veins may have a zone of adjacent quartz stringers (Knopf, 1929, p. 25). Examination of many of the veins shows that they were repeatedly reopened during formation, giving rise to several generations of vein minerals.

Large bodies of low-grade ore also occur adjacent to Mother Lode veins as wall-rock replacements, particularly in altered greenstone and schist; more rarely, high-grade ore is found in similar environment, as at Carson Hill, Calaveras County. Ore bodies of auriferous schist commonly consist of stockworks where schist masses are laced with gold-bearing veinlets; the schist itself may be partly replaced by ore minerals. Hydrothermally altered greenstone or gray ore, as it is locally called, forms important ore deposits in the southern part of the Mother Lode, notably at the Eagle Shawmut mine in Tuolumne County. Such deposits also occur to a lesser extent in Amador County and in other parts of the Mother Lode.

The Mother Lode vein system cuts a considerable variety of wall rocks, notably the Upper Jurassic Mariposa slate, greenstones and meta-sediments of the Upper Jurassic Amador group, greenstones and schists of the Paleozoic Calaveras group and serpentine. Valuable ore shoots have formed adjacent to all of these wall-rock types but in general, slate appears to have been most favorable for ore deposition and serpentine least favorable (Knopf, 1929, p. 31). Although Mother Lode veins appear to conform roughly to attitudes of the enclosing rocks they actually cut these rocks in dip and less commonly in strike (Fairbanks, 1890, p. 10, and Knopf, 1929, p. 24). Veins commonly are deflected in angle of dip when passing from one type of wall rock to another, the greatest deflection generally occurring at black slate-greenstone contacts (Knopf, 1929, pp. 24-25).

Most of the gold in Amador County is found as native metal, alloyed with a little silver. It may occur in masses easily seen with the naked eye or, more commonly, disseminated in specks of microscopic size. Gold is most commonly associated with quartz, but sulfide minerals containing free gold as a replacement or as fracture filling are in many cases the source of most of the valuable metal. Gold tellurides are found in some parts of the Mother Lode, but are not present in notable quantities in Amador County.

The East Belt district is roughly elongate parallel to the Mother Lode 10 to 15 miles east. It consists of numerous individual veins which do not constitute a closely knit system and do not always have a common trend. Many of the veins have a northerly strike; others are oriented east or northeast. Most of the veins are steeply dipping as in the Mother Lode, but East Belt veins generally are narrower and contain smaller, richer ore bodies. Wall rocks are generally granitic, older metamorphic rocks being much more sparsely distributed than in the Mother Lode belt.

Mines in Amador County that have produced more than $1,000,000 worth of gold.

Name	Total production	Name	Total production
Kennedy	$34,280,000	Zeila	$5,000,000
Argonaut	25,179,160	Fremont-Gover	5,000,000
Keystone	24,000,000	Wildman and Mahoney	5,000,000
Old Eureka	19,000,000	Original Amador	3,500,000
Central Eureka	17,000,000	Oneida	2,500,000
Plymouth Consolidated	13,500,000	Lincoln	2,200,000
South Eureka	5,300,000	South Spring Hill	1,092,472
Bunker Hill	5,154,382	Treasure	1,000,000

Lode Gold Mines

Amador Queen No. 2. Location: sec. 34, 35, T. 6 N., R. 11 E., M.D.M., 2 miles south of Jackson. Ownership: Judge Ralph McGee, Sutter Creek, California.

The chief production of gold from this mine was prior to 1900. By that date the greater part of the underground workings had been developed (Logan, 1934, p. 108). From 1918 (Logan, 1934, p. 60) to 1941 the mine was operated intermittently, with a production of a few thousand dollars nearly every year. The mine was worked intermittently by the Garibaldi Brothers from 1930 to 1941, according to Mr. Frank Garibaldi. In 1948 an unsuccessful attempt was made to treat the tailings.

The Amador Queen No. 2 was worked through a 1200-foot west-driven adit. Drifts were run 1000 feet south and 460 feet north from the end of the adit. Also a winze 900 feet deep was sunk along the dip of the slate with levels at 500 and 700 feet (Logan, 1934, p. 60). In the 1930's a 230-foot winze was sunk about 100 feet from the end of the adit.

Gold occurs with arsenopyrite in quartz stringers in east-dipping Mariposa slate (Logan, 1934, pp. 60-61). The slate is interlayered with schist, some of it being hard and siliceous. In the last ten years of operations, production was chiefly specimen ore.

Amador Star mine. Location: sec. 23, T. 8 N., R. 10 E., M.D.M., 3 miles north of Plymouth. Ownership: Eliza M. Kaiser, 720 West Poplar Street, Stockton, California.

The mine was originally developed through a 422-foot crosscut adit from which some ore was produced prior to 1900. (Logan, 1934, p. 61.) Little mining was done thereafter until 1917 when a 580-foot vertical shaft was sunk approximately 700 feet southwest of the adit portal. Ernest A. Stent continued intermittent development work through the 1920's. More development work by the Amador Star Mining Company was done on the 300 level in 1931.

In 1932, Arthur Hamburger took an option on the property and produced gold during 1933. Under his direction, West America Consolidated Gold Mines, Inc., produced gold from the mine again in 1934. During 1934, a crosscut was extended eastward on the 500 level and other old workings were cleaned out. During the first part of 1935, some drifting was done on the 500 and 800 levels of this mine. The project was abandoned in 1935 as only a few thousand dollars worth of gold was produced and little or no new ore was found, according to Mr. T. Calvert Slater.

The vein, which ranges from $2\frac{1}{2}$ to 9 feet in thickness, occurs in a north-striking half-a-mile wide belt of Mariposa slate. In the wider parts of the vein there are quartz stringers containing considerable pyrite. The small amount of ore milled in the last operation averaged about $6.00 per ton (Logan, 1934, p. 62).

Workings consist of a vertical shaft about 900 feet deep, about 600 feet of drifts on the 300 level, over 600 feet of drifts and a 1000-foot crosscut on the 500 level, and some drifts on the 800 level.

A 75-ton flotation mill equipped with Hardinge ball mills was operated on the property during the early 1930's. Forty men were employed

FIGURE 4. Headframe of Amador Star mine.

at the mine and mill in this operation, according to Mr. Slater. All of the equipment has been dismantled and removed.

Argonaut Mine. Location: sec. 20, T. 6 N., R. 10 E., M.D.M., one mile northwest of Jackson on highway 49. Ownership: B. Monte Verda and E. C. Taylor, 369 Pine Street, San Francisco, California.

This mine, originally known as the Pioneer, was first worked in 1850. Until 1893, it was a small-scale operation which received little attention. Most of the early work was through an adit on the northern end of the claim (Logan, 1927, p. 153).

In 1893 the Argonaut Mining Company was incorporated. Except for interruptions caused by fires, operations were continuous from this date until 1942. In the spring of 1919 a severe underground fire caused the loss of a year's production as the fire was not brought under control until the lower workings of this mine and the adjoining Kennedy were flooded. On August 27, 1922 a fire on the 3350-foot level caused the loss of 47 lives. This also stopped production for a year (Logan, 1927, p. 154).

From 1923 to October, 1938, tailings produced in the early years of operation were treated by the Amador Metals Reduction Company, according to Mr. S. E. Woodworth, metallurgical engineer who worked the tailings. In 1941, the Argonaut Mining Company constructed a cyanide plant to treat concentrates from the Argonaut mill and those from the Plymouth Consolidated mine.

Although ore in the mine was by no means exhausted, production ceased on March 28, 1942. This was due to the high costs of materials, the scarcity of labor, and wartime limitations on gold mining. Until 1948, however, the upper part of the mine was kept unwatered and in

repair in hopes of eventual reopening. In December 1947, the directors of the company recommended dissolution of the Argonaut Mining Company and by February 1948, a majority of the stockholders had given their consent.[5] The mine has since passed into the hands of B. Monte Verda and E. C. Taylor of San Francisco. The machinery is being removed.

The Argonaut vein ranges from 8 to 10 feet in width in the upper workings. At the 4200 level and below, the vein widens to 20 and 30 feet. The vein strikes from N. 10° W. to N. 18° W. At the 290 level the vein dips 40° northeast. From the 470 level to the 4050 level the vein dips 64°, and below the 4050 level the dip ranges from 60° to 63° northeast (Tucker, 1914, p. 19).

The Argonaut vein occupies a fissure apparently opened by a reverse fault (Knopf, 1929, p. 67). To a depth of 290 feet, it is in altered metavolcanic rocks. From the 290-foot level to the 470-foot level the vein cuts a belt of Mariposa slate. At the point where the vein passes into the slate it appears that the thrust fault has a throw of 120 feet, the hanging-wall being thrust upward over the footwall to at least that distance (Tucker, 1914, p. 19). To a depth of 2500 feet the vein is on or near the contact of the Mariposa slate footwall and metavolcanic hanging wall.

A stringer vein which branches into the hanging-wall from the Argonaut vein at a depth of 1200 feet was the subject of a well-known controversy. The Kennedy Extension Mining Company in their famous lawsuit with the Argonaut, contended that this vein belonged to them since it was the older of the two veins. The courts ruled in favor of the Argonaut Mining Company (Logan, 1934, p. 63).

Below the 2500 level the footwall is largely Mariposa slate, and the vein is separated from the hanging-wall of gray-colored schist by a thin band of slate.

The best ore occurred in a ribboned structure of quartz and slate which was within a few feet of the footwall. This ore was free-milling and contained about 2½ percent of sulfides, largely pyrite (Logan, 1934, p. 67). Specimen rock was found in places.

The Argonaut mine was developed through a three-compartment 60° inclined shaft 5700 feet deep. The deepest level of the mine was the 6300-foot level which was developed from an inclined winze sunk from the 5550 level 300 feet south of the shaft. The 6300-foot level has a vertical depth of 5570 feet. In the last two years of operations, the principal production was from stopes between the 6150 and 6300 levels. During this same period there was development work underway on these levels and to the south on the 4800 level. There are approximately 8 miles of drifts, crosscuts, and tunnels, 4 miles of raises, and 50 miles of stope floors (Bowen and Crippen, 1948, p. 64).

Before 1936, milling was done in a 60-stamp mill. After stamping, the pulp was concentrated, classified, and the tailings were cyanided. In 1936, ball mills and flotation cells were installed making it possible to raise recovery to 94 percent.[6] A process for elimination of graphite slimes from the flotation pulp by controlled agitation was developed at the Argonaut. This process greatly increased the efficiency of the cyanidation of Mother Lode ores.

[5] Logan, C. A., unpublished report, 1948.
[6] Logan, C. A., unpublished report, 1948.

To December 31, 1942, total mine production was 2,750,000 tons of ore from which $25,179,160.43 was recovered and dividends of $3,789,-750 were paid on an original capitalization of $1,000,000.[7]

Ballard Mine. Location: E$\frac{1}{2}$W$\frac{1}{2}$ sec. 14, T. 8 N., R. 10 E., M.D.M., a quarter of a mile south of the Cosumnes River on highway 49. Ownership: Ballard Mother Lode Mines, Inc., c/o John Ratto, Sutter Creek, California.

Originally worked in the 1870's by the Spanish Mining Company, this gold mine lay idle until the Lopez Mining Company reopened it in 1928 (Logan, 1934, p. 70). The main shaft was reopened and a 10-stamp mill was installed. The operation failed soon afterward and the property was idle until 1933. John Ratto purchased the mine from the Ballard estate in 1931. The property was again active from 1933 to 1937 and from 1941 to 1942. A small amount of work was done in 1947. According to John Ratto, the Ballard Mother Lode Mines Company was incorporated in 1935 with Ratto as the principal stockholder. The mine is now idle.

There are three parallel quartz veins approximately 600 feet apart in Mariposa slate. They strike N. 10° W. and dip 68° east. The ore, which is chiefly free gold associated with pyrite in a ribbon structure of quartz and slate, occurs in a 250-foot ore shoot in the west vein, west of the main shaft, in a 550-foot shoot in the middle vein east of the main shaft and in another smaller 60-foot ore shoot on the middle vein 1000 feet to the south, according to Mr. Ratto.

The main shaft, which was sunk between the west and middle veins, is 285 feet deep with approximately 600 feet of crosscuts connecting both main ore shoots at the 200-foot level. The Ballard shaft, south of the main shaft, is 200 feet deep with 400 feet of crosscuts north of the shaft. Ore exposed in these southern workings has not been completely developed. According to John Ratto, assays have been as high as 180 dollars per ton but the average is around 10 dollars per ton in $35 per ounce gold.

Belden Mine. Location: NW $\frac{1}{4}$ sec. 26, T. 7 N., R. 13 E., M.D.M., about one mile southeast of Buckhorn Lodge. Ownership: Belden Amador Mines, Inc., P.O. Box 28, Fort Wayne, Indiana.

This mine was mentioned in 1867 (Browne, 1868, p. 80) as having been in operation ten years, with a roasting furnace and a five-stamp mill. During this early work a depth of 250 feet was reached.[8]

Little work was done in later years until the present company began operations on September 13, 1936. The mine was shut down in 1938 and re-opened in 1939 by the Belama Corporation, a leasing concern composed of stockholders of the Belden Amador Mines, Inc. The Belden mine was the largest gold producer on the East Belt in Amador County from 1940 until government war-time restrictions closed the mine in November, 1942. The mine was reopened in 1947 with the resumption of ore production in 1948, according to Leon Banks, Superintendent. In 1949, the mine again shut down for lack of water necessary for mining and milling operations. At the present time the mine is inactive pending the outcome of a lawsuit with the Pacific Gas and Electric Company.

[7] Logan, C. A., unpublished report, 1948.
[8] Logan, C. A., unpublished report, 1948.

FIGURE 5. Belden mine. Mill in right background, hoist house on left.

The gold occurs in stringer quartz veins in granodiorite. The main vein strikes N. 15° W. and dips east. There are three en echelon ore shoots that dip steeply to the east. The gold content in the ore is 50 percent free gold and 50 percent auriferous pyrite with a little pyrrhotite, according to Mr. Banks. Minor amounts of galena and sphalerite are also present. The ore bodies are faulted to the west toward the south with a displacement amounting to 20 to 25 feet along three major faults. As a result of hand sorting the ore before milling, assays of the mill feed averaged $56 per ton during 1948. The average gold value prior to this date was $41 to $42 per ton, according to Mr. Banks.

The 160-, 250-, 300-, and 350-foot levels were driven off a 400-foot, two-compartment, vertical shaft. Since 1936, the company has worked the mine from the 200-foot to the 400-foot level and has stoped a length of about 400 feet along the strike. There are several thousand feet of drifts in the mine, some of them being as much as 500 feet in length. The ore is hoisted from the mine in 1500-pound buckets.

Ore is beneficiated in the company mill, the capacity of which is twenty tons per day with a 92 to 93 percent recovery. The ore is washed, hand sorted, and crushed by a primary jaw crusher and a secondary ball mill. The fines are pumped to a Diester rubber-covered table and concentrated into free gold, pyrite concentrates and middlings. The free gold is amalgamated in a Denver amalgam barrel, retorted, and sold as bullion to the mint in San Francisco. The middlings are run through a corduroy-lined launder, and then to a classifier from which the oversize is returned to the ball mill while the fines are sent to a four-cell Denver flotation machine. The froth concentrate, along with the pyrite concentrate, is filtered, dewatered, and shipped to the Empire Star mine in Grass Valley for further treatment.

The mine has produced gold worth $400,000 since 1936, according to figures furnished by Mr. Banks. When in full production, 25 men operate the mine and mill, producing 40 tons per day.

Black Prince Mine. Location: SE $\frac{1}{4}$ sec. 27, T. 7 N., R. 13 E., M.D.M. about $1\frac{1}{2}$ miles southeast of Buckhorn Lodge. Ownership: This property consists of three unpatented mining claims, the Coeur Leonie, the Coeur Leonie fraction, and the Aurora, owned by a partnership composed of P. M. Wedell and W. R. Schwickerth who resides at the mine.

This property was operated by Jack Howald in the early 1930's and produced a total of $50,000 worth of $35 per ounce gold during this time, according to Mr. Schwickerth. In 1936, the property was sold to the present owners and since that time, small amounts of work have been done intermittently.

Free gold occurs with pyrite and smaller amounts of chalcopyrite in a series of quartz veins which strike approximately N. 8° W. and dip steeply to the east. The country rock is granodiorite. The Black Prince vein, which is the main vein, is about 3 feet wide. The Black Fox vein is 550 feet west of the Black Prince vein while the Aurora vein is 550 feet east of the Black Prince vein. Assays from ore shoots of the Black Prince vein average $90 per ton in $35 per ounce gold, according to Mr. Schwickerth.

The main workings consist of three adits which have been driven along the Black Prince vein in a general direction of N. 8° W. These adits are each separated by a vertical distance of about 100 feet. The lower adit has been driven 600 feet, the middle adit, 450 feet, and the upper adit, 225 feet. Mining and development work consists of cross-cutting, raising, and stoping off of these levels. A 720-foot adit has been driven on the Aurora vein and an 85-foot adit has been driven on the Black Fox vein. There is no mining equipment on the property.

Black Wonder Mine. Location: SE $\frac{1}{4}$ sec. 5, T. 6 N., R. 12 E., M.D.M., two miles southwest of Pine Grove just east of state highway 88. Ownership: George B. Taves and Florence J. Taves, Pine Grove, California.

Work started at this mine in 1931 under a partnership consisting of Bert Caldwell, Nick Contini and Dean Wiley. In 1933 and 1934 it was sub-leased to Weise and Holmes. During 1933, 800 pounds of ore containing $173 worth of $20.67 per ounce gold was shipped to the smelter of Selby, California, according to Mr. Caldwell. The mine was shut down in 1935 and has been idle since that time.

Free gold associated with pyrite and small amounts of chalcopyrite and some galena occurs in a 3- to 4-foot-wide quartz vein. The vein strikes northwest and dips 60°-70° southwest. The country rock consists of blocky greenstone.

Up to 1933, the inclined shaft was 90 feet deep. In 1934, the shaft was retimbered and sunk an additional 30 feet. Also at this time a 30-foot drift was driven in a northwesterly direction off the 45-foot level. A 9-inch vein of galena was encountered near the end of this drift, according to Mr. Caldwell.

Ore was treated in a mill equipped with a jaw crusher, an air-operated five-stamp mill and amalgamation plates. Four to six men operated the mine and mill.

Bunker Hill Mine. Location: sec. 25, 36, T. 7 N., R. 10 E., M.D.M., ¼ mile north of Amador City. Ownership: Bunker Hill Mining Company, c/o D. C. Crandall, North Bend, Washington.

Originally known as the Rancheria mine, the Bunker Hill was first worked in 1853. During the 1860's and 1870's, ore yielding from $50 to $75 per ton was being produced (Logan, 1934, p. 72). An inclined depth of 800 feet was reached in 1888. In 1893, after having been idle for several years, the mine was renamed the South Mayflower and reopened.

In 1899, the Bunker Hill Consolidated Mining Company was organized and operated the mine steadily until 1922. During this period 887,585 tons of ore was produced which yielded $3,834,550. Since 1922 the mine has been idle except for a small amount of work done in 1925. A total of $5,154,382 in gold was produced (Logan, 1934, p. 72). The company paid dividends of about $1,000,000 on an original capitalization of $200,000.

The principal vein is the Bunker Hill vein, or the hanging-wall vein. Other veins, including the "gouge vein" and the Last Chance vein, lie in the footwall (Knopf, 1929, p. 55). From the surface to the 200 level the Bunker Hill vein occurs along a greenstone-Mariposa slate contact, the greenstone lying to the east (Tucker, 1914, p. 20). The vein is in slate from the 200 to the 1400 levels, and below the 1400 level the vein crosses interlayered bands of slate and greenstone. The vein strikes northwest, dips to the northeast, and averages five and a half feet in width. Gold associated with pyrite and some arsenopyrite occurs in quartz veins and greenstone ("gray ore"). Some mineralized black slate, heavily charged with both pyrite and arsenopyrite, that was in the footwall at the north end of the 2200-foot level proved to be ore (Knopf, 1929, p. 55). West of the Bunker Hill vein on the 1400 level a body of auriferous greenstone ("gray ore") was developed.

The mine was developed by a two-compartment, 2800-foot inclined shaft sunk on an angle averaging 58°. An inclined winze was sunk from the 2800 level to a depth of 3440 feet. The last work was done on the 3200 and 3400 levels. Ore was mined by square-set stopes and later filled with waste. Shrinkage stopes were employed in the auriferous greenstone.

Ore was milled in a 40-stamp mill. Milling was accomplished by primary crushing, stamps, amalgamation, and concentration on Deister tables. Sands were reground in a ball mill and the entire pulp was then concentrated on 24 Frue vanners.

Central Eureka (Including Old Eureka) Mine. Location: SW ¼ sec. 8, T. 6 N., R. 11 E., M.D.M., at the town of Sutter Creek. Ownership: Central Eureka Mining Company, 2210 Russ Building, San Francisco, California.

Previous to 1924, the Central Eureka mine and the Old Eureka mine were operated as two independent gold mines. In 1924 the Central Eureka Mining Company, which had been operating the Central Eureka mine for 28 years, acquired title to the Old Eureka mine and the two mines were consolidated (Logan, 1934, p. 103).

The Central Eureka mine was originally located as the Summit mine in 1855. It worked continuously from that date until 1875. The mine was reopened in 1895 (Storms, 1900, p. 64) when the Central Eureka

Mining Company began operations. Profitable exploitation continued until 1907 when the mine was shut down for one year, reopening again in 1908. During 1924, the company purchased holdings of the Old Eureka mine but it was not until 1930 and thereafter that the production of ore had shifted from the Central Eureka workings to the Old Eureka workings (Logan, 1934, p. 75).

The Old Eureka mine was opened in 1852. In 1859, Alvinza Hayward consolidated an adjoining claim with the Old Eureka and by 1867 56 stamps were crushing ore. In March, 1869, the mine was purchased by the Amador Mining Company for $750,000. (Logan, 1934, p. 101.) The new operators continued mining until 1881. The mine was idle from 1881 to 1916 when dewatering and mining operations were resumed; it was again shut down in 1920. Some work was done in 1924 at the time the present operators purchased the mine but it was not until 1930 that the lower workings of the Central Eureka mine were abandoned in favor of the ore bodies of the Old Eureka mine. All of the ore produced since 1930 by the Central Eureka Mining Company has been from the Old Eureka workings. Mining operations were suspended in 1942 but the mine was kept in working order during World War II. Mining was resumed in 1946, but little ore was produced until 1948.

In 1951, 39,440 tons of ore yielded a little more than $500,000 in gold and silver, according to Morton A. Ralls, superintendent. Total production for the Central Eureka mine, which includes the Old Eureka and Central Eureka, to the end of 1951 is approximately $36,000,000.

Mineralized zones in the Central Eureka and Old Eureka mines consists chiefly of quartz, quartz-ankerite-albite rock, ribboned structures of quartz and slate and hydrothermally altered greenstone or ''gray

FIGURE 6. Shaft of Central Eureka mine.

FIGURE 7. Central Eureka mill and cyanide plant. Flag in upper righthand corner shows location of Central Eureka shaft.

ore.'' Gold alloyed with silver may be in a free-milling state in any of these rocks or it may be disseminated in pyrite where fine crushing is necessary to free it from the host minerals. Pyrite and arsenopyrite are common and sphalerite, chalcopyrite and galena are present in minor amounts, according to Mr. Ralls.

The veins strike essentially north, dip steeply eastward and, although they pinch and swell, have an average width of about 8 feet. In some places the width may reach 20 feet. Wall rocks may be Mariposa slate, Logtown Ridge greenstone, or Cosumnes graywacke, all of Jurassic age. Slates commonly form the footwall along major faults.

The most pronounced structural feature in the Old Eureka mine is the Wolverine reverse fault, which on an average strikes north 20° west and dips 65° east. (Norman, 1939.) In the upper 1700 feet of the mine, faulting has occurred along the contact of Mariposa slate and Logtown Ridge greenstone. Below the 1700-foot level, the footwall remains slate but the hanging wall becomes a series of dense and slaty greenstones. (Logan, 1934, p. 103.) Between the 2500 and 3000 levels, the measurable displacement was observed to be more than 300 feet. Rich ore bodies occur along the Wolverine fault as irregular shattered quartz lenses within gouge.

Workings consist of two inclined shafts, the Central shaft which is 4855 feet deep, and the Old Eureka shaft which is 3500 feet deep. The Central shaft is 1800 feet south of the Old Eureka shaft. Each is a two-compartment shaft with an average incline of 65° east. The lower levels off the Old Eureka shaft are worked through an 11- by 5-foot inclined winze sunk from the 3500 to the 4150 level. The main haulage way for the mine is the 3500 level. All of the ore is hoisted up the Central shaft while the haulage of men, waste, timber, supplies, and occasional bailing of water is confined to the Old Eureka shaft.

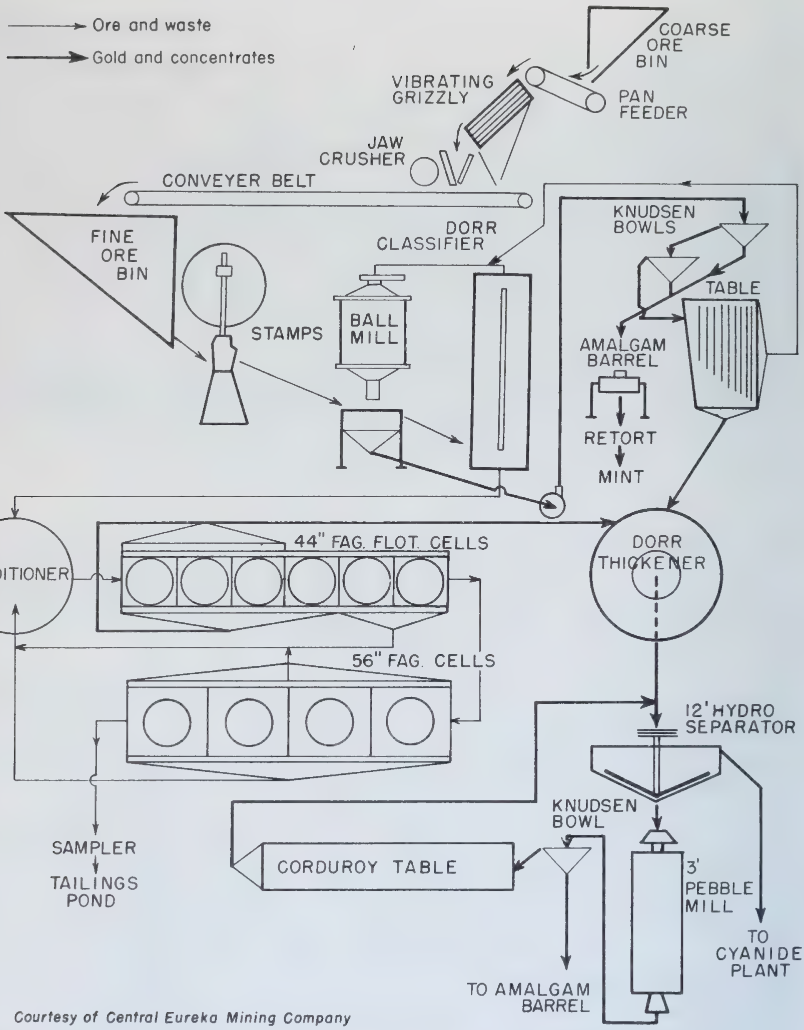

FIGURE 8. Flow sheet, Central Eureka mine, courtesy Central Eureka Mining Company.

The cut-and-fill method of stoping is used. Since 1946, sand has been used to fill the stoped-out areas, but prior to World War II, waste was used, according to Mr. Ralls. Swedish Copco Atlas pneumatic drills with detachable bits and tungsten carbide inserts are used for drilling. Ore from the stopes is loaded into mine cars, trammed to transfer chutes, and hoisted up the 3500 winze to the 3500 level. Electric battery locomotives transport the ore-laden mine cars 3000 feet south to the Central shaft where the ore is hoisted to the surface in 3-ton skips.

As there is considerable gouge ranging from 1 to 6 feet in thickness on both the hanging and footwall on many of the levels, stopes must be timbered close to the face.

Since 1948, mining has been done on the 2900, 3100, 3400, 3500, 3600, 3700, 3800, 3900, and 4150 levels. The principal work being done at the present time is north of the Old Eureka shaft on the 3700, 3800, 3900, and 4150 levels through the 3500 winze.

Between 1935 and 1938, the Central Eureka Mining Company ran exploration drifts north from the 2100 and 2500 levels of the Old Eureka workings into the Lincoln Gold Mining Company's property. A total of 2467 feet of drifting and crosscutting was completed on both levels, but no commercial ore was located, according to T. Calvert Slater, former superintendent.

Ore is run through a jaw crusher, 30-stamp mill, jig, classifier, conditioner, and flotation cells. The gold and concentrate from the jig is delivered to two Knudsen bowls, an amalgam barrel, retorted, and sent to the U. S. Mint in San Francisco. The gold and concentrate slimes from the Knudsen bowls are tabled and sent to a Dorr thickener. Slimes from the flotation cells are also sent to the Dorr thickener. The gold and concentrates from the thickener are delivered into a 12-foot hydro-separator. The products from this separation either go to the cyanide plant or are reground in a ''pebble mill'' and sent to another Knudsen bowl. The fines from the bowl are delivered to the amalgam barrel while the slimes are run over a corduroy table and recirculated through the hydro-separator. Mill recovery averages about 95 percent. Mill capacity is 9 tons per hour. Approximately 70 percent of the gold is recovered by amalgamation and 30 percent is recovered from the cyanide concentrates. Ratio of concentrates sent to the cyanide plant is from 30-40 to one.

The mill discharge of sand is delivered into settling tanks where one pound of aluminum sulfate is added to each ton of discharge to aid in settling. Thirty percent of the discharge is discarded on the tailings pond, while the remaining 70 percent of the sand is mixed with water to give a 65 percent solid—35 percent liquid mixture. This mixture is piped down the Old Eureka shaft and used as fill. It is possible to deliver up to 30 tons of sand per hour for use as filling, according to Morton A. Ralls.

Three shifts of men per day operate the mine on a six-day work week. Mining is done during two shifts while repair work is done on the third shift. Miners are paid on a contract basis and are paid by the linear foot. The total payroll includes 90 to 125 men.

Contini (Mikado) Mine. Location: W ½ sec. 9, T. 6 N., R. 12 E., M.D.M., 1.8 miles southwest of Pine Grove. Ownership: Bert Contini

of Jackson owns two unpatented mining claims, the IXL and the Three Horsemen.

In 1889-1890, this mine was worked in conjunction with the Wheeling mine, one mile to the east, according to Nick Contini. In 1932 the claims were relocated by Nick Contini and were worked from 1935 to 1939 and again in 1950.

Coarse free gold occurs in quartz with pyrite and small amounts of chalcopyrite and galena. Secondary blue and brown opal are common on this property. The vein varies from 6 to 12 feet in width, strikes northeast, and dips 60° to 70° southeast. Country rock consists of blocky greenstone cut by granitic dikes.

The workings on the IXL claim are a 250-foot southeast-trending tunnel, a 60° to 70° inclined, now-caved winze and approximately 200 feet of crosscuts. The Three Horsemen claim has a 20-foot adit about 200 feet east of the IXL adit portal. There is no equipment on the property.

In the period of 1935 to 1939, about $6000 in gold was produced. Small amounts of ore were produced in 1950 and during the winter of 1951-52 when about 20 tons of ore were shipped to Pine Grove for milling.

Defender Mine. Location: SE¼SW¼ sec. 29, T. 7 N., R. 13 E., M.D.M., half a mile southeast of Pioneer Station. Ownership: West Point Consolidated Mines Company, c/o E. H. Outerbridge, 250 Park Avenue, New York, New York.

The mine was worked intermittently under lease from the 1900's to 1938. Between $20,000 and $30,000 of gold was produced during the 1930's, according to R. Moar, former miner. The mine has been inactive since 1938.

Free gold and pyrite associated with some galena, sphalerite and chalcopyrite occur in a 20-inch-wide quartz vein. The vein strikes N. 15° W. and dips 85° southwest (Tucker, 1914, p. 27). Country rock is granodiorite. The last ore produced in 1938 assayed from $7.00 to $9.00 per ton in gold, according to Mr. Moar.

The mine is exploited by a 480-foot inclined shaft. On the 200 level, a 300-foot north drift and a 150-foot south drift were driven. Most of the ore produced was between the 200 level and the surface. There is no equipment on the property; the shaft is caved. During the last year of operation, 1938, a 75-ton milling plant was completed. Approximately 35 men were employed at the mine and mill, according to Mr. Moar.

Elkhorn Mine. Location: SW¼SE¼ sec. 29, T. 7 N., R. 13 E., M.D.M., a quarter of a mile southeast of Pioneer Station. Ownership: This property is a patented mining claim owned by Mary and Sadie R. Grillo of Volcano, California.

Two caved shafts, one 100 feet north and the other 300 feet south of the Elkhorn mine shaft, are part of the old workings that were actively mined during the early 1890's. Edward Schaefer of Pioneer Station leased the property in 1939 and operated it until government order L-208 closed the mine in 1942. The property was leased to the present operators, a partnership consisting of V. F. Pierce and W. H. Riddle of Sacramento, and F. C. Hamburg of Loomis in January of 1950, according to Mr. Pierce. At the present time the partnership is sinking a new shaft. The property is worked intermittently.

Free gold occurs in a $2\frac{1}{2}$-foot wide north-striking quartz vein and stringers in granodiorite. Associated with the gold is pyrite and some chalcopyrite, sphalerite, bornite, and arsenopyrite.

The mine has a two-compartment vertical shaft, 85 feet deep, with a 20-foot drift north and a 35-foot drift south, both off the 75-foot level. Ore is brought to the surface by a three cubic-foot bucket, the hoist of which is powered by a 1928 Chevrolet engine. A model 315 Worthington gasoline compressor supplies compressed air to operate the pneumatic rock drills while a 450 g.p.m. pump is used to dewater the mine. The vertical Haywire shaft, now caved, is 300 feet south of the Elkhorn shaft; the former is 175 feet deep, with two levels at 125 and 175-foot depths.

Fort Ann (Acme, Robinson) Mine. Location: E $\frac{1}{2}$ sec. 2, T. 7 N., R. 12 E., M.D.M., $3\frac{1}{2}$ miles north of Volcano. Ownership: William L. Metcalf, Box 32, Volcano, California.

This mine was worked prior to 1895 (Crawford, 1896, p. 66) and in 1895 there was a 10-stamp mill on the property. Between the late 1890's and 1935 the mine was largely inactive. In 1934 J. C. Nimmo worked the mine tailings for gold. In 1935, the Fort Ann Mining Company, which was organized by J. C. Nimmo and F. W. Kent, both of Los Angeles, and William Anderson of San Diego, reopened the mine. Mining operations continued steadily from 1935 until 1941, according to Mr. George Garland, former miner. In the fall of 1939, the company had completed erection of a 75-ton-daily-capacity milling plant on the property. In September, 1944, W. L. Metcalf and G. C. Rubke, both of Volcano, leased the mine. There has been no production of ore since 1941 and only maintenance work has been done at the mine since that date.

The ore occurs as free gold with accompanying pyrite in a quartz vein and stringers. Country rock is green schist and slate. A 300-foot nearly vertical shaft is now caved.

During the 1930's, a west adit was driven several hundred feet into the side hill, according to Mr. Lee Gardner, former miner. From this adit, other crosscuts and drifts were driven.

Ore was hand trammed from the mine to the 75-ton mill which is located about 200 feet southeast of the adit portal. The ore was crushed in a jaw crusher and ball mill, conveyed to a trommel, Dorr classifier, and two Wilfley tables. The concentrates from the tables were sent to the amalgam barrel while the tailings were deposited in a tailings pile. The electrically powered mill remains on the property and the adit is kept open.

Fremont-Gover Mines. Location: sec. 25, T. 7 N., R. 12 E., M.D.M., one mile east of Drytown. Ownership: Fremont Gover Company, c/o C. B. Braun, Route 3, Box 306, Albany, Oregon.

The Loyal Lode mine, now part of the Fremont Gover, is known to have been in operation prior to 1867. In 1872 the Fremont and Gover Company was formed, and during the 1880's and 1890's worked principally on the Gover claim (Logan, 1934, p. 82). In the meantime the Loyal Lode was reopened and produced ore yielding between \$7 and \$8 a ton. Production from the Gover varied from \$50,000 to \$70,000 per year in the late 1880's and early 1890's.

FIGURE 9. Fremont mine. Scale is shown by man standing in front of headframe.

In 1900 the Fremont shaft was started and in 1903 a new 40-stamp mill was erected. Operations continued until late in 1918 (Knopf, 1929, p. 52). From 1920 to 1923, Metals Exploration Company prospected and produced some ore from the property. A small amount of work was done in 1925 by Fremont-Gover Mines Company, organized by former employees. Shortly after, Black Hills Fremont Mines Company did a little work in an adit and in a 100-foot winze.

Early in 1937 the property was reopened by Amador Mother Lode Mining Company. In September of 1937 the property was purchased by the Fremont Gover Company who operated it until April of 1940. In this last operation there was some production. The Gover shaft was reopened to the 865 level and the Fremont to the 770 level. Several thousand feet of new drifts, crosscuts, and raises were driven.

Total production of the property has been in excess of $5,000,000 (Bowen, 1948, p. 65). Dividends of $316,000 were paid.

The gold-quartz vein on the Fremont-Gover property strikes N. 25° W. and dips 50° east. The average thickness of the vein is 6 feet (Tucker, 1916, p. 28). Gold was produced from slate-quartz ore, pockets in quartz stringers extending into the greenstone, and auriferous greenstone or "gray ore." Arsenopyrite, as well as pyrite, is commonly present.

At the Gover mine, the vein occupies a fault-fissure having an observed displacement of 375 feet. From the surface to the 170-foot depth, the vein is in slates while from that depth to the 600 level the vein has a greenstone hanging-wall and a slate footwall. Below the 600 level, the vein is in greenstone. The vein is narrow in the slates, but widens in depth, 50 and 60 feet being commonly reached (Knopf, 1929, p. 54).

Below the 900-foot level and extending to the 2300 level in both the Gover and Fremont claims was a large body of ''gray ore.'' The ''gray ore'' occurred in a zone up to 70 feet wide. (Logan, 1934, p. 84.) Several other lenses of ''gray ore'' were mined between the 800 and 2500 levels. Quartz-slate and pocket veins were developed in the upper levels of the Fremont shaft.

The Fremont shaft is 2950 feet deep on a 51° incline. Levels are 200 feet apart. The main Gover shaft, which is 1430 feet north of the Fremont, is 1500 feet deep on an incline. Drifting was extensive from both shafts. The 1500 level of the Gover connected with the 1350-foot level of the Fremont. Mining was done partly by square setting and partly with stulls, all stopes being filled. (Logan, 1934, p. 84.)

The mill contained 40 stamps and had a capacity of 200 tons per day. Concentration was on Frue vanners. From 1914 to 1920 the tailings were worked on a royalty basis by the California Slimes Concentrating Company. Tailings were treated by regrinding, concentration, and cyanidation.

Hageman Mine. Location: NE. $\frac{1}{4}$ sec. 33, T. 7 N., R. 13 E., M.D.M., 500 feet east of the West Point Power House. Ownership: Four unpatented claims owned by Frank E. Cotie and Vernie Hoffschneider and leased by a partnership consisting of E. V. Grant, R. R. Brown, and E. C. Anderson.

The Hageman adit was driven in the early 1920's and some high grade ore was taken from the Hageman vein. (Logan, 1922, p. 7.) In 1947 the Sunny Boy vein was uncovered during the construction of the new West Point road. The property was leased soon afterward by the Dowdel Brothers, who sank a 50-foot shaft on the Sunny Boy vein and produced over $20,000 to 1951. The present operators leased the property early in 1952 and are working intermittently to extend the Sunny Boy adit west to encounter the Sunny Boy vein, according to Mr. Grant.

The Sunny Boy vein strikes north and dips 52° west. It ranges from a few inches up to 3 feet in width. The gold occurs in pockets and is associated with pyrite and small amounts of galena.

Workings consist of the 150-foot northward-extending Hageman adit, the Sunny Boy adit 200 feet to the west, which extends 150 feet in a westerly direction toward the Sunny Boy vein and the 50-foot inclined shaft about 150 feet north of the Sunny Boy portal. At the 50-foot level there is a 60-foot drift south.

Italian (Black Hills) Mine. Location: SW$\frac{1}{4}$ sec. 24, T. 7 N., R. 10 E., M.D.M., about one mile northeast of Drytown. Ownership: Black Hill Mining Company, c/o William Tam, Jackson, California.

The mine began producing gold in the early 1860's (Logan, 1934, p. 85), after which it was idle until operations were resumed for a short period during 1890. It was reactivated in 1932 and remained in operation until 1940. Since that time, no production has been recorded.

Free gold, which occurs in quartz between a slate footwall and a greenstone hanging wall, has been recovered from several thousand feet of crosscuts, winzes, drifts, and stopes.

A five-stamp mill was used during the productive years of 1932 to 1940. At the present time, there is considerable mining equipment remaining on the property, including grinding equipment, concentrating

tables, hoists, compressors, several hundred feet of track and some ore cars.

Between the years 1932 and 1940, approximately $140,000 worth of gold was produced, according to figures provided by the owner.

Jumbo Mine. Location: SW $\frac{1}{4}$ sec. 26, T. 7 N., R. 13 E., M.D.M., about 2 miles southeast of Buckhorn Lodge. Ownership: Four unpatented mining claims are owned by a partnership consisting of Behrend Doscher, George Viscovich, and Steve Miloservich.

These claims were located by Joe Lawrence of West Point during 1950. The present owners purchased the claims in 1951, according to Mr. Doscher.

There is a north-south belt of mineralization approximately 6 feet wide in granodiorite. Within this zone are 1- to 3-inch quartz stringers and quartz pockets. The ore consists of free gold with quartz, some pyrite, and smaller amounts of chalcopyrite and malachite. The vein crops out 3000 feet along the strike north of the river. Near the river the vein is nearly vertical but toward the north it dips to the west.

Parts of the vein in the second adit assay $12 per ton in gold, $12 per ton in the open cut, and $121 per ton in the main zone on the lower level. Hanging-wall samples in the granite vary between $14 and $28 per ton in gold, according to information received from Mr. Doscher.

Development work consists of a 20-foot north-trending adit 50 feet above the river, a second 65-foot, northeast-trending adit 125 feet above the first adit on the same level as the Pacific Gas and Electric Company's road, and a 20-foot open cut 65 feet above and to the east of the second adit.

There is a 60° inclined tramway between the second and first adits. An air-operated hoist with a $\frac{3}{4}$-ton skip utilizing a 25-foot wooden headframe hauls the ore up the tramway from the lower adit to the level of the road where the mill is located. The ore is crushed to minus $\frac{1}{2}$-inch by a jaw crusher and conveyed by conveyor belt to a ball mill. Free gold is recovered in a Knudsen bowl while the fines are sent to the classifier and flotation cells. The electric power is supplied by Pacific Gas and Electric Company.

Kennedy Mine. Location: SW$\frac{1}{4}$SW$\frac{1}{4}$, sec. 16, T. 6 N., R. 11 E., M.D.M., one mile north of Jackson. Ownership: Mark and Frances Eudey, Martell, California.

The original Kennedy claim was located in 1856 and in 1860 several properties were consolidated to form the Kennedy mine. These properties were patented in 1872. Little work was done until the Kennedy Mining and Milling Company purchased the mine in 1885.

A 40-stamp mill was erected in 1886. During the 1890's approximately 36,000 tons of ore per year was being produced (Logan, 1934, pp. 86-87). In 1900 the present east vertical shaft was started. From that date on the Kennedy was one of the largest producers in the Mother Lode. Between 140,000 and 170,000 tons of ore per year was produced in the 12 years prior to 1916 (Logan, 1934, p. 87). A fire in 1919 in the Argonaut mine spread to the Kennedy workings through tunnels which connected the two mines. Production was halted as the fire was not brought under control until the lower workings of both mines were flooded.

FIGURE 10. Kennedy mine. To right is partially dismantled stamp mill.

As the mine increased in depth and mining costs increased, it was necessary to mine more selectively so that from the middle 1920's until 1942 the tonnage of ore produced decreased, according to Mark Eudey, owner and former superintendent. On September 7, 1928, a disastrous fire destroyed all of the surface plant except for the mill and main office. The surface plant was rebuilt in 1929. In 1935 a 1500-ton cyanide plant was erected south of the mine to re-treat accumulated tailings from the mill. This was in operation until 1939.

From 1929 to 1941 the chief production was between the 4650 and 5900 levels, the inclined winze having been started in 1929.

In August, 1941, increasing costs caused all work below the 4650 level to be discontinued. According to Mr. Eudey, from this time until the mine closed, preparations were underway to mine known ore from that level and above.

The mine was closed in November, 1942, in compliance with U. S. Government Order L-208. Except for the steel headframe, all of the surface plant including the buildings have since been sold.

In 1948-49, the tailings were worked intermittently by Frank Fuller, Jr. of Jackson and from 1949-50 by Michael Hagel of Sacramento. Hagel's project was not successful. In September, 1950, the Kennedy Mining and Milling Company went out of existence, thus ending one of the best known mining operations in California. The gold lodes were, however, by no means exhausted and further mining merely awaits development of more favorable economic conditions.

Total production of the Kennedy mine with the price of gold calculated to fit various price changes is approximately $34,280,000 (Bowen and Crippen, 1948, p. 64). Five and one-half million dollars in dividends were paid on an original capitalization of $100,000.

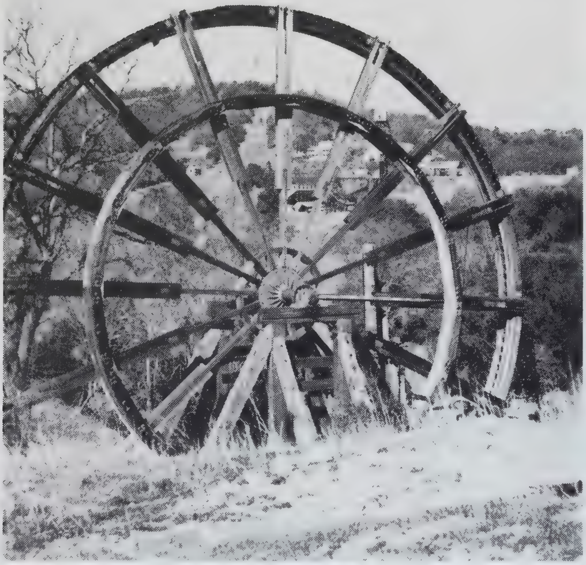

FIGURE 11. Three of the tailings wheels at the Kennedy mine. Mine shows through spokes of wheel to right. *Photo by Mary R. Hill.*

The main Kennedy vein strikes N. 20° W. and dips 70° E. The ore is free gold in quartz with auriferous pyrite and minor amounts of galena. The ore bodies of this mine are not continuous either longitudinally or in depth. The thickness of ore mined usually ranged from 8 to 15 feet. Generally, the best ore is in ribbon rock of hard white quartz containing numerous ribbons of finely ground slate or fine-grained pyrite and galena, according to Mr. Eudey, and to a depth of 4800 feet the ore remained at a fairly constant gold value; however, at greater depths the ore occurred as irregular masses. Little specimen ore was recovered.

Wallrock consists of Logtown Ridge greenstone and Mariposa slate. Below the 3150 level the vein is wholly in slate as the narrow greenstone mass near the vein in the upper levels pinches out at this depth (Logan, 1927, p. 168). An east vein, which was encountered between the 1700 and 2200-foot levels and extends to the bottom levels, has been formed by the breaking away of a large horse of the hanging wall slate. At the widest part of the horse, this vein is 150 feet from the main vein. This vein joins the main vein both north and south of the shaft.

The Kennedy was developed through a three-compartment vertical shaft 4764 feet deep. Work at the lowest levels was done through an inclined winze off the 4650-foot level. The greatest vertical depth reached was 5912 feet, making the Kennedy the deepest mine in North America. There are approximately 50 miles of underground workings, according to Mr. Eudey.

Prior to 1931, milling was done with a 100-stamp mill. At that time a ball mill and flotation cells were installed. The stamp mill was then used for primary crushing. From 1936 until the mine closed, an average of

3000 tons of ore per month were milled. Total mining and milling costs averaged 10 dollars per ton. The last full crew at the mine and mill was 125 men.

For twenty years prior to 1934, tailings were stored behind a dam south of the shaft. They were transported to the dam by 2000 feet of flume. Tailing-elevator wheels 56 feet in diameter were used. Pictures of these large wheels often appear in publicity and travel folders of the Mother Lode.

Keystone Mine. Location: sec. 36, T. 7 N., R. 10 E., M.D.M., within the city limits of Amador City. Ownership: Keystone Mining Company, c/o John D. Culbert, Amador City, California.

One of the most profitable mines in the Mother Lode was the Keystone which produced $24,000,000 (Bowen and Crippen, 1948, p. 65). The Keystone mine was formed from several claims originally located in 1851. During the early period of operations much high-grade ore was produced so that dividends as high as $550 per share per month were declared (Knopf, 1929, p. 58).

By 1888 most of the high-grade ore had been exhausted. Mining operations continued until the mine closed in 1919. From 1911 to 1919, the Keystone Mining Company operated the mine (Logan, 1934, p. 92) and in 1920 the company gained control of the South Spring Hill mine adjoining the Keystone property on the east side.

In 1933 the Keystone was reopened by Keystone Mines Syndicate. Production was underway by 1935 and continued until the fall of 1942 when the mine was closed down by governmental order L-208. During this last period of operation about $1,000,000 was produced, according to T. S. O'Brien. Since that date the mine has been idle except for a small amount of work done in 1952 in the Wonder mine which is just east of the main shaft.

The main Keystone or contact vein varies from 12 to 200 feet in width and occurs on the contact between slate and greenstone, the former being the footwall and the latter the hanging wall (Tucker, 1914, p. 35). The vein dips 35 to 65 degrees east. East of this vein is the Spring Hill or East vein. Ore, which varied greatly in value, occurred both in the veins and quartz stringers branching off the veins. Ore was free gold in quartz associated with pyrite and small amounts of arsenopyrite and stibnite. Some of the sulfides were auriferous.

The mine was worked through the main or Patton shaft, which is 2680 feet deep on a 52 degree incline and is located between the Spring Hill and Keystone veins. Production was from the 900 to the 2100 levels, although the principal production was from the 1400 to the 2100 levels, according to Mr. O'Brien. Crosscuts run both to the east and to the west. Below the 2100 level there was very little production. Ore was first crushed at the Keystone and then trucked to the Original Amador mine where it was milled and cyanided. Just prior to the closing of the mine in 1942, about 300 tons of ore per day were milled.

About 100 men were employed at the mine and mill, according to Mr. O'Brien.

Lincoln Consolidated Mines. Location: secs. 6, 7, 8, T. 6 N., R. 11 E., M.D.M., in Sutter Creek and extending north for 1 mile along the Mother Lode. Ownership: Lincoln Gold Mining Company, 807 Lonsdale Building, Duluth, Minnesota.

Lincoln Consolidated Mines include the Lincoln, Wildman, and Mahoney mines, which were operated separately until 1906 when the Lincoln Consolidated Mining Company gained control of the three properties. The Lincoln mine is the farthest north, the Mahoney is south of the Lincoln, and the Wildman, the most southern adjacent to the town of Sutter Creek. All three mines were originally located about 1851 and worked during the 1860's.

In the 1860's the Lincoln was worked through two shafts and produced 3500 tons of ore per year (Logan, 1934, p. 95). It lay idle until 1898 when it was reopened by the Lincoln Gold Mine Development Company (Storms, 1900, p. 75). Old workings were cleaned out and there was some production for several years.

The Wildman, idle since 1867, was reopened in 1887 and was in operation until 1906. The Mahoney, active in the 1870's and 1880's, was purchased by the Wildman Company in 1894 and operated with the Wildman until 1906. All three properties passed into control of Lincoln Consolidated Mines in 1906. In 1910 the Wildman and Mahoney were reopened and operated until 1912, since which date they have been idle.

Combined production of the Wildman and Mahoney was slightly less than \$5,000,000, while the Lincoln produced \$2,200,000 (Bowen and Crippen, 1948, p. 64).

In the area of the three mines the Mariposa slate is interfolded with meta-andesite which has been partially altered to amphibolite schist (Tucker, 1914, p. 37). In the upper levels of the Wildman and Mahoney the ore occurs in a contact vein along the slate-schist contact (Logan, 1934, p. 96). Below the 500-level in the Wildman and the 250-level in the Mahoney the belt of mineralization passes into altered schist. Besides the main belt of mineralization a number of small ore shoots in the schist were developed. The ore bodies pitch southward.

The Lincoln was worked through a 2000-foot inclined shaft, the Wildman through a 1400-foot inclined shaft, and the Mahoney through a 1200-foot inclined and a 616-foot vertical shaft. The three claims were connected by a drift running south from the 2000 level of the Lincoln through the Mahoney to a point under the Wildman shaft. Stoping extended to the 1400 level of the Wildman and to the 1200 of the Mahoney while there was no production below the 500 level of the Lincoln.

Both the Wildman and Mahoney Mines were equipped with 40-stamp mills. (Tucker, 1914, p. 37.)

Moore Mine. Location: sec. 34, T. 6 N., R. 11 E., M.D.M., 1½ miles south of Jackson. Ownership: South Jackson Mining Company, c/o J. Schweitzer, Jackson, California.

This mine was active in the 1880's. During that time it had been opened to a depth of 640 feet. Ore was milled in a 10-stamp mill. From that time it was idle until 1921 when it was reopened by the Moore Mining Company, who operated the mine until 1929. Intermittent prospecting continued until around 1934, since when it has been idle. From 1922 to 1929 production amounted to \$564,624. (Logan, 1934, p. 98.)

The Moore vein system occurs in and near the fault contact of a northwest-trending belt of Mariposa slate and greenstone. The dip is to the east. Greenstone forms the hanging wall and slate the footwall. At the deeper levels the vein is badly shattered. The main ore shoot worked during the early period of operation was 1200 feet long and

averaged 16 feet in width. It was cut off at a depth of 750 feet by faulting. Small amounts of ore were found on the 1100 level, and between the 1800 and 2100 levels an irregular ore body was mined. Much of the ore found at the deeper levels occurs in badly faulted vein segments and lenses.

Workings consist of a 2291-foot inclined shaft, drifts, crosscuts, and stopes. Many of the underground workings are a result of the extensive prospecting done in the 1920's. During this time several long crosscuts were driven east and west, none of which disclosed any ore. Ore was milled in a 20-stamp mill erected in 1922.

Nevada Wabash Mine. Location: NW ¼ sec. 6, T. 6 N., R. 11 E., M.D.M., adjoining the North Star mine, 1 mile north of Sutter Creek. Ownership: Nevada Wabash Mining Company, Box 504, Sutter Creek, California.

In 1946 the Nevada Wabash Mining Company had a lease on the Wabash mine property. Under the direction of R. V. Kohls a 420-foot southeast adit 600 north of the adjoining North Star mine was cleaned out and extended for a short distance. A 15-inch vein dipping northeast in greenstone was encountered.[9]

There was no production and work was abandoned soon afterward, according to J. Schweitzer, mining engineer.

New Hope Mine. Location: SW ¼ sec. 3, T. 7 N., R. 10 E., M.D.M., 1 mile west of Plymouth. Ownership: Harold and Emma Swingle, Plymouth, California.

By 1890, a shaft 75 feet deep had been sunk on this property. (Irelan, 1890, p 121.) The records show no production from the mine since 1880. In 1947, diamond drilling by the owner indicated an 18-inch-wide ore body averaging 65 dollars per ton in gold values. A new 85-foot vertical shaft was then sunk and a 65-foot drift was run to the south at the 85 level. The small ore body indicated by the drilling consisted of free gold with pyrite in quartz veinlets in greenstone, according to Ernest V. Grant, mining engineer. Additional diamond drilling is under way east of the shaft. The property is intermittently worked by two men.

Newman Mine. Location: NE ¼ sec. 33, T. 7 N., R. 13 E., ½ mile northeast of the West Point Power House just north of where the highway crosses the Mokelumne River. Ownership: This property was acquired by Pacific Gas and Electric Company, San Francisco, California, for right-of-way for construction of the West Point tunnel.

The outcrops were worked superficially in the early days by the Chinese and Mexicans. This property was located and patented in 1928 by the China Garden Mining Company of Missouri who operated it until 1933. A total of $160,000 in gold had been taken from this mine by the end of 1933 when the mine was closed, according to W. E. Stirnaman, former miner.

The gold occurs in 1-to-10-foot wide quartz veins which strike northwest and are almost vertical. Country rock is granodiorite.

A 1400-foot, north-trending adit has a 200-foot winze 400 feet from the portal. The vein has been stoped out to the surface along the strike 500 feet from the portal. This property was equipped with a 10-stamp mill, concentrators and an air compressor.

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[9] Logan, C. A., unpublished report, 1949.

Oneida Mine. Location: sec. 17, T. 6 N., R. 11 E., M.D.M., 1½ miles north of Jackson. Ownership: South Eureka Mining Company, c/o A. J. Mayman, 400 California Street, San Francisco, California.

One of the important early-day lode mines, the Oneida was producing ore averaging as high as 40 dollars per ton in the 1860's (Logan, 1934, p. 111). It was operated intermittently from that date until the late 1890's when much extensive development work was done and a new mill erected. Operations continued until 1914, since which date it has been idle. Total production of the Oneida was in excess of $2,500,000 (Bowen and Crippen, 1948, p. 64).

The vein occupies a fissure chiefly in slates near the contact with greenstone which lies to the west (Tucker, 1914, p. 39). The main ore shoot is 8 feet wide and 150 feet long and is near the shaft. North of this is an irregular-shaped ore body. A small but rich ore body was developed to the north of this on the 1000 level. Best ore was on the 1500 level, although there was production down to the 2000 level where some coarse gold was found in a thin quartz seam (Storms, 1900, p. 63).

Workings included a 2280-foot vertical shaft in the hanging wall, which cut the vein at the 1900 level, a 1350-foot inclined shaft, and two other shallow inclined shafts. The Oneida was connected with the South Eureka mine on the 1800-foot level (Tucker, 1914, p. 39).

Ore was milled in a 60-stamp mill. When in full operation 40 or 50 men were employed at the mine and mill.

Original Amador Mine. Location: sec. 36, T. 7 N., R. 10 E., ¼ mile north of Amador City. Ownership: J. W. Bullock, c/o C. E. Crandall, North Bend, Washington.

This mine, a consolidation of six claims, was originally opened in 1852. By 1872 workings extended to a depth of 365 feet and a 40-stamp mill was erected. From 1874 to 1898 little work was done other than intermittent prospecting. Between 1898 and 1918 the Original Amador Consolidated Mines Company operated the mine. From 1910 to 1918 production was between $90,000 and $130,000 per year (Logan, 1934, p. 104).

The property lay idle until early in 1935 when it was reopened under the direction of Hamilton, Beauchamp, and Woodworth. The mill was reconditioned and its capacity was increased. Operations were suspended in the middle of 1937, since which date the mine has been idle.

After the mine closed the mill was operated until 1942 by Keystone Mines Syndicate to treat ore mined at the Keystone, according to T. S. O'Brien. Estimated total production for the Original Amador is $3,500,000 (Bowen and Crippen, 1948, p. 65).

Near the surface, the main Original Amador quartz vein ranges from 20 to 50 feet in thickness (Tucker, 1914, p. 39). The vein is represented by two branches which are separated by greenstone. The footwall of the west vein is thinner and of better grade than the hanging-wall branch. The thickness of this vein ranges from a thin fissure to 5 feet of solid quartz (Knopf, 1929, p. 57). The maximum width of the hanging-wall branch is 90 feet. The hanging wall is greenstone while the footwall is slate. Below the 300 level the veins enter the greenstone and assume a flatter dip. Ore was obtained in part from the Original Amador quartz vein and in part from large irregular masses of auriferous greenstone occurring in the hanging-wall of the quartz vein (Knopf, 1929, p. 57).

Workings consisted of a 1238-foot inclined shaft and over nine miles of drifts, crosscuts, and raises. Because of the firm wall and width of ore, shrinkage stoping was used on the main vein (Logan, 1934, p. 105).

The mill at the Original Amador mine had a capacity of 300 tons per day. Ore was crushed, screened, run through a 20-stamp mill, and concentrated on Diester tables. Concentrate was then reground in Hardinge ball mills and cyanided.

Peterson Mine. Location: NE ¼ sec. 5, T. 6 N., R. 12 E., about one mile southwest of Pine Grove. Ownership: William F. Peterson, Pine Grove, California.

In 1931, W. F. Peterson purchased the mine from J. Cuneo and operated it continuously until the government wartime restrictions closed the mine in 1942. Total gold output between the years of 1931 and 1942 amounted to approximately $250,000, according to Mr. Peterson. It was not until 1948 that production was once again resumed, this time under the guidance of H. P. Livingston, president of the Lomar Milling Company.

The ore consists of leaf gold and disseminated gold in quartz with associated pyrite and arsenopyrite, and occurs in the contact zone between greenstone and granite. Ore deposition appears to be controlled by block faults in which the dominant strikes are northeast. The largest vein and secondary veins have a north strike while other important veins strike east. All of the veins are nearly vertical. One highly mineralized shear zone about 50 to 60 feet wide was encountered 560 feet from the portal of the 200 level. Selected ore assays $40 to $60 and better per ton while the mill run ore assays about $30 per ton, according to Mr. Livingston.

Most of the present development work and the small amount of stoping has been confined to an adit which is termed the 65-foot level. There are two other caved adits which are termed levels, the 200 and 270. The ore is trammed in a small ore car by hand out of the 65-foot level and deposited in a storage bin before it is hauled to the mill by truck. Reopening work started in 1952 on the old 200-foot level which constituted the original adit.

About a quarter of a mile southeast of the mine, the company maintains an assay laboratory and a mill. Ore is run through a jaw crusher and then a 5-stamp mill. Fines are directed over an amalgamation plate while the tailings are impounded.

Since reopening of this mine in 1948, the mining operations have concentrated on development work, consequently, only a small production of gold has been recorded. H. P. Livingston and W. F. Peterson do all the mining and milling.

Pine Grove Mine. Location: SW ¼ sec. 23, T. 7 N., R. 13 E., M.D.M., one mile southeast of Buckhorn Lodge. Ownership: Wendell M. Miller, et al., c/o E. A. DeRuchia, Reno, Nevada.

This mine was originally developed by Wendell M. Miller and associates about 1935 and was worked intermittently until 1941. From 1944 to January 20, 1950 the mine was operated by Associated Metals, Inc. During this time 40 to 50 tons of ore assaying up to 80 dollars per ton were produced, according to Sheriff Harry James, former operator. The mine has been inactive since January, 1950.

Free gold associated with pyrite, chalcopyrite, and galena occurs in a 1- to 5-foot quartz vein in granodiorite. The vein strikes northwest and dips steeply west. Some diamond drilling was done in 1946. Hayes Evans reported that during the last months of operation the ore assayed \$13.00 in gold and \$8.00 in silver.

Workings consist of a 90-foot inclined shaft, several hundred feet of drifts, and 100 feet of crosscuts. There are two levels, the 45-foot and 90-foot levels. An old shaft 400 feet to the south was connected to the main workings, according to Mr. James.

Pine Grove Unit Mine. Location: SE $\frac{1}{4}$ sec. 32, T. 7 N., R. 12 E., M.D.M., $\frac{1}{4}$ mile southwest of Pine Grove and adjoining the Peterson mine. Ownership: W. F. Peterson, Pine Grove, California.

Work started on this property in 1938 by W. F. Peterson. H. P. Livingston leased the property in 1946 and operated the mine until 1948. Mr. Livingston reported that in the later 1930's, \$5,000 in gold was produced.

The ore consists of free gold associated with smaller amounts of bornite and sphalerite in a quartz vein which strikes east and dips about 55° south. The vein varies from a few inches to 3 feet in width. Country rock is Calaveras slate. Eight hundred tons of \$27.00 per ton gold ore is blocked out at the 60-foot level, according to Mr. Livingston.

A 187-foot inclined shaft was sunk on the vein. Other development work consists of 200 feet of east-trending drifts on the 60-foot level and several hundred feet of drifts on the 120-foot level.

Pioneer Lucky Strike Mine. Location: SE $\frac{1}{4}$ sec. 20, T. 7 N., R. 13 E., M.D.M., $1\frac{3}{4}$ miles northeast of Pioneer Station. Ownership: J. H. Hauhuth, Pioneer Station, California.

Discovery work on this property began in 1921 by Rudolph Moar and brothers. After the late 1920's the mine was worked almost continuously by several different lessors until 1941. The mine produced \$300,000 in gold during the period of 1921 to 1941, according to Mr. Moar.

Free gold is associated with pyrite in three ore shoots. The shoots are located in a quartz vein which varies in width from 6 inches to 5 feet, the average being 28 inches. The veins strike N. 50°-55° W. and dip steeply to the southwest. Country rock is granodiorite.

Workings consist of an 1100-foot southeast adit and an 180-foot winze sunk 170 feet in from the portal. Most of the ore from the adit to the surface has been stoped.

Ore was run through a 30-ton mill. The owners reported that 30 men were employed at the mine and mill when in full operation.

Plymouth Consolidated Mine. Location: sec. 11, T. 7 N., R. 10 E., M.D.M., in the city limits of Plymouth. Ownership: B. Monte Verda and E. C. Taylor, 369 Pine Street, San Francisco, California.

The claims that formed the Plymouth mine were originally located in 1852. They were worked separately until consolidation in 1883 under the name of Plymouth Consolidated Mining Company.

In 1888 a severe fire was not brought under control until the mine was flooded. The mine was idle from 1892 to 1911. In 1911 the Plymouth Consolidated Mine Company, Limited, was incorporated and acquired the property. In 1925 it was sold to the Argonaut Mining Company (Logan, 1934, p. 107).

FIGURE 12. Plymouth Consolidated mine, Empire shaft.

Little work was done between 1928 and 1939 but a combined flotation and cyanide plant was put into operation by the Argonaut Mining Company to treat tailings. Frank Standridge reported that during this time, a small amount of exploration was done in the upper levels, principally the 400 and 500 levels, of the Empire shaft. This operation shut down in 1943.

In 1946, the Empire workings of the Plymouth Consolidated mine were reopened by the Argonaut Mining Company. This was a resumption of prospecting interrupted by World War II. On the 400 level an old drift was extended north for about 700 feet. Only a small amount of pocket ore was encountered and work ceased early in 1947, according to Mr. Standridge.

The Plymouth is the most northern of the major mines of the Mother Lode in Amador County. Total production is estimated to be in excess of $13,500,000 (Bowen and Crippen, 1948, p. 65).

There are three parallel vein systems called the Empire, Reese, and Woolford and several hanging-wall contact veins in a mile-wide belt of Mariposa slate; the veins have a general north strike and dip 65° east (Tucker, 1914, p. 41). The Empire vein system contains the main ore shoot which varies from 4 to 16 feet in width. In the deeper levels ore is composed chiefly of a ribbon structure of slate and quartz.

Prior to 1923, the main or Pacific shaft was sunk to a depth of 3400 feet. At that time ore had been mined through a winze, hoisted to the 3400 level, trammed to the Pacific shaft, and then hoisted to the surface. In 1925, the Pacific shaft was sunk to a depth 4450 feet, of which the first 1600 feet is vertical and the balance on an incline of 60 degrees. The principal ore body between the winze and shaft has been stoped out as far down as the 4300 level. Some of the last work done before the mine closed in 1928 was between the 4450 and 4300 level (Logan, 1934, p. 107).

The Empire ore shoots were worked through the 1280-foot inclined Empire shaft. During the last phases of operations this was reconditioned to the 500 level. Approximately 350 feet north of this shaft is the 1065-foot North Empire shaft.

The Plymouth mine was the first in the Mother Lode to have ore delivered to the mill from the shaft by conveyor belt (Logan, 1934, p. 195). Ore was then delivered to 30 stamps and then to cone separators to separate the fines, while the coarse feed was reground in two Hardinge ball mills. The pulp was then sent to amalgamation plates, classifiers, Wilfley tables, and vanners. Capacity was 420 tons per day.

Rainbow Mine. Location: NE ¼ sec. 32, T. 7 N., R. 12 E., M.D.M., 1½ miles northwest of Pine Grove. Ownership: Claude Hanley, 1727 Hiawatha Avenue, Stockton, California.

Prior to 1935, this property was a small prospect. In 1935, C. Evans and W. W. Evans of Glendale purchased the property and began to sink a shaft. The mine was worked continuously from 1935 until the fall of 1941 but has since been idle.

Ore consists of free gold in quartz with pyrite and galena. The quartz vein which varies from 8 to 14 feet in width, strikes east and dips to the north. Several north-striking quartz stringers branch off the main vein. Pocket gold is very characteristic at this mine. Country rock is Calaveras slate.

In 1935, an inclined shaft was sunk to a depth of 157 feet where it intersected the main ore shoot. This shaft caved and a new inclined shaft 150 feet east was sunk to a depth of 200 feet. At the 200-foot level off the new shaft, a drift was driven about 200 feet to the west, according to Mr. Ruffino. There are a number of buildings on the property but all the equipment has been removed.

Red Hill Mine. Location: NE ¼ sec. 32, T. 7 N., R. 12 E., M.D.M., 1½ miles northwest of Pine Grove. Ownership: Claude Hanley, 1727 Hiawatha Avenue, Stockton, California.

A gold-quartz vein was discovered on this property in 1946. Development work continued intermittently until 1949 since which date the property has been idle. Prior to 1949 the mine was under lease to H. P. Livingston of Pine Grove and approximately $5000 in gold was produced, according to Lee Gardner.

Ore consists of free gold in quartz associated with pyrite and small amounts of chalcopyrite and bornite. The nearly vertical gold-quartz veins strike north and occur in sheared and fractured zones within Calaveras slates and schists.

An 84° inclined shaft was sunk 120 feet. At the 100-foot depth a 58-foot drift was driven north. At the 50-foot depth two crosscuts were driven, one 30 feet east and the other 100 feet west. A 20-ton mill, which was erected on the Red Hill property but never operated, was moved to the Italian mine near Drytown. Four to six men were employed at the mine, according to Mr. Gardner.

South Eureka Mine. Location: sec. 17, T. 6 N., R. 11 E., M.D.M., one mile south of Sutter Creek. Ownership: South Eureka Mining Company, c/o A. J. Mayman, 400 California Street, San Francisco, California.

This mine was originally developed in 1891 and during much of its period of operation was one of the largest producers in the country (Logan, 1934, p. 112). Until 1908 production was moderate from small ore bodies in the hanging-wall vein. In 1908 the footwall vein system was discovered. From this date until the mine closed in 1917, over 980,000 tons of ore were produced (Logan, 1934, p. 113).

In 1921 the Central Eureka Mining Company took an option on the property and did some exploratory work from the Central Eureka mine into the South Eureka mine (Logan, 1934, p. 112). Also for a time they kept part of the workings unwatered and the shaft in repair. Total production of the South Eureka was \$5,300,000 (Bowen and Crippen, 1948, p. 64) from which about \$1,000,000 in dividends were paid.

At this mine the Mother Lode system occurs in and along a belt of Mariposa slate which is several hundred feet wide. Greenstone (meta-andesite of the Logtown Ridge formation) is on both sides of this slate belt (Knopf, 1929, p. 63). Three veins were developed: the hanging-wall, footwall, and middle veins (Tucker, 1916, p. 47). The hanging-wall vein is on the slate-greenstone contact to a depth of 2000 feet where the vein passes into the greenstone. Ore occurs in bunches in slaty gouge, in pockets, streaks in greenstone, and at the junction of the footwall vein and the middle vein below the 2000-foot level. The chief mine production was from this ore body between the 2750 and 2000 foot levels.

The mine was developed through a 2785-foot inclined shaft. Crosscuts were run east and west to the ore bodies. A winze was sunk to the 2900-foot level but no ore was found. When the Central Eureka had the property under option they extended several of the deeper levels of the Central Eureka mine into the South Eureka, the deepest being the 4100-foot level. The result of this work was disappointing as no ore was found (Logan, 1934, p. 112).

Ore was milled in an 80-stamp mill with a capacity of 400 tons per day. The ore was crushed, run through a 24-mesh screen, amalgamated, and concentrated on 48 Frue vanners. Mill recovery ranged from 85 to 91 percent. At full production, 200 to 250 men were employed at the mine and mill.

South Spring Hill Mine. Location: sec. 31, T. 7 N., R. 11 E., M.D.M., ½ mile south of Amador City. Ownership: Keystone Mining Company, c/o John D. Culbert, Amador City, California.

This mine was located in 1851 and worked continuously until 1893. In 1887, a 30-ton stamp mill was crushing 70 tons of ore daily (Logan, 1934, p. 91). The mine was reopened in 1900 and closed again in 1902. In 1920, title to this property was acquired by the Keystone Mining Company. Unwatering of the South Spring Hill shaft began in the middle of 1934 by the Keystone Mines Syndicate in conjunction with the reopening of the Keystone mine. The South Spring Hill and Keystone shafts were retimbered and connected by underground workings. Since the company was primarily interested in mining ore from the Keystone, no ore was produced from the South Spring Hill mine during this time. Although there was work done at this mine from 1934 to 1942, there has been no recorded production of ore since 1902. Total production from 1888 to 1902, inclusive, amounted to \$1,092,472 (Logan, 1934, p. 91).

The gold-quartz vein strikes northwest, dips 52° to 85° northeast, and is about 20 feet wide; its greatest width measures 50 feet. Country rock consists of a slate footwall and a greenstone hanging-wall. A heavy gouge on the footwall is a common occurrence.

The property has been developed by three inclined shafts, South Spring Hill, Talisman, and Medean, which are 1200, 600, and 600 feet deep, respectively. Talisman and South Spring Hill shafts are about 2300 feet apart and connected underground. These shafts were sunk on the contact vein while the Medean shaft was sunk on a parallel lead to the east in greenstone.

Treasure (Hazard) Mine. Location: sec. 25, T. 7 N., R. 10 E., M.D.M., one mile north of Amador City. Ownership: Treasure Mining Company, 220 Montgomery Street, San Francisco, California.

Prior to 1867 the Treasure mine had produced 5000 tons of ore. It lay idle until 1907 when the Treasure Mining Company reopened it. It was operated until 1922, since which date it has been idle. Total production of the Treasure mine was about $1,000,000; however, no dividends were paid as the surplus was exhausted looking for more ore (Logan, 1927, p. 184).

The Treasure vein, in which there are two ore shoots, is in slate to the 400 level where the vein passes into schist. The dip which is to the east, is shallow near the surface and steepens to 65° to 70° in the schist. The two shoots average six feet in width and vary from 90 to 400 feet in length (Tucker, 1914, p. 50). A disseminated ore body 700 feet long and 18 feet wide in schist was developed on the 1000 level. The best ore was above the 2320-foot level below which a fault cut off most of the ore.

Workings consisted of a 1600-foot inclined shaft, and winzes which reach an inclined depth of 3030 feet. Levels were 160 feet apart. The 1600 level was connected with the 1500 level of the Bunker Hill to the south (Logan, 1934, p. 182).

Treatment of the disseminated ore differed from the standard practice on the Mother Lode. Ore was run over a one-inch grizzly with the oversize being sent to a gyratory crusher and then to a trommel. The oversize from there was sent to a jaw crusher. Coarse ore was conveyed to a large Hardinge mill while fine ore was conveyed to a smaller one. From the ball mills it passed to a screen and shaking plates. Pulp from the plates was sent to classifiers, Wilfley tables, concentrators, and Frue vanners. Capacity was 150 tons in 24 hours.

Valparaiso (Black Metal) Mine. Location: sec. 10, T. 5 N., R. 11 E., M.D.M., 4½ miles south of Jackson. Ownership: Valparaiso Mining Company, Jackson, California.

This mine was worked prior to 1888 and gold ore was produced until 1898. From 1898 until 1931, the mine is credited with producing $100,000 in gold (Logan, 1934, p. 114). Gene Boro reported mining gold worth $600 in 1937. From 1937 to 1939, a partnership composed of Leo Dunlavy, Charles Spencer, and Dean Wiley mined the property intermittently. Approximately $5000 in gold was produced from small pockets from 1937 to 1939, according to Mr. Dunlavy. The mine has been idle since 1939.

Gold occurs in pockets, quartz veins, and quartz stringers in greenstone and Mariposa slate. The workings are concentrated in a heavily faulted area along the slate-greenstone contact, and consist of a 1300-foot adit, drifts, crosscuts, raises, winzes, and stopes, according to Mr. Boro.

Wonder Mine. Location: sec. 36, T. 7 N., R. 10 E., M.D.M., about 150 feet east of the Keystone mine shaft. Ownership: Keystone Mining Company, c/o John D. Culbert, Amador City, California.

This property was leased from the Keystone Mining Company by a partnership consisting of Martin Ares, George Thurman, and John Rodriquez in January of 1952. At that time, the operators began sinking an inclined shaft which they called the Wonder mine. Mining operations were suspended in May of 1952 when the new workings ran into the old workings of the Keystone mine at a depth of 65 feet.

The ore was a weathered, iron-stained quartz containing pyrite, and exceeded $25 per ton in gold, according to Mr. Ares.

Zeila Mine. Location: sec. 28, T. 6 N., R. 11 E., M.D.M., on the southeast side of Jackson. Ownership: Mark and Frances Eudey, Martell, California.

The Zeila produced over $5,000,000 in gold. It was first worked in the 1860's and by 1867, there was a 16-stamp mill crushing the ore and a chlorination plant treating the concentrates. The mine was closed in 1875 but reopened again in 1880 and operated continuously until 1914 (Logan, 1934, p. 115). The mine has been inactive since 1914 and subsequent to that date it passed into possession of the Kennedy Mining and Milling Company. Mine tailings are utilized by the Amador County road department for use as fill from time to time.

Ore occurs in quartz stringers on the contact of greenstone and Calaveras slate and schist. The vein, which averages 20 feet in width, dips 65° east (Tucker, 1914, p. 52). Gouge occurs on the footwall of the main vein only and ranges from a few feet to fifty feet in thickness. The highest grade ore occurs in the quartz-ribbon structure.

The shaft was sunk 1700 feet on an angle of 65°. On the 1570-foot level, a drift was driven 3000 feet north from the shaft, at which point a winze was sunk on the vein to a depth of 458 feet. One hundred and fifty-seven feet below the 1570 level, a 352-foot drift was driven north on the vein from the winze. Two hundred and ninety-five feet below the 1570 level, a 450-foot drift was driven north.

Gold Mine Tailings

Argonaut Tailings. Location: sec. 20, T. 6 N., R. 11 E., M.D.M., one mile north of Jackson. Ownership: B. Monte Verda and E. C. Taylor, Box 367, Jackson, California.

From 1923 until October, 1938 the Amador Metals Reduction Company under the direction of Hamilton, Beauchamp, and Woodworth, consulting engineers of San Francisco, treated the tailings of the Argonaut mine for the gold content. During this operation about 70.000 tons of tailings per year were treated with a recovery averaging $60,000 per year, according to S. E. Woodworth.

Tailings were hydraulicked from the tailings pile into a classifier. Both sands and slimes from the classifier were pre-coated with coal tar to prevent pre-precipitation of the dissolved gold in the cyanide solu-

tion because of the carbon present. The sand was then treated in leaching vats while the slimes were directed to an agitator and filtered on Oliver filters. Sand and slime residues were discarded. The gold-bearing solution was then precipitated, roasted, and the gold melted into bullion. When in operation, six men were employed at the plant.

Central Eureka Tailings. Location: SE $\frac{1}{4}$ sec. 7, T. 6 N., R. 11 E., M.D.M., at the Central Eureka mine in Sutter Creek. Ownership: Central Eureka Mining Company, 2210 Russ Building, San Francisco, California.

In 1930, a partnership consisting of Hamilton, Beauchamp, and Woodworth, consulting engineers of San Francisco, and Glen O'Brien of Ione took an option on the Central Eureka mine tailings. The plant operation started in 1932 and continued steadily until 1938. Eight hundred and eighty thousand tons of tailings were treated, according to Mr. O'Brien. Assay values varied from $1.50 to $3.00 per ton, on the basis of $35 per ounce gold. Recovery approximated 70 percent.

The tailings pile was sluiced by hydraulic means to a classifier through a sand pump. Both sands and slimes were then treated with three pounds of coal tar per ton to prevent pre-precipitation because of the carbonaceous content. The sand was treated in leaching vats on an eight day cycle. The slimes were directed to an agitator, thickener and filters. Both sand and slime residues were discarded. Precipitation was achieved by treating the solution with the Merrill-Crowe process. Precipitates were then acid treated, roasted, and melted into gold bars. Mr. O'Brien reported that capacity of the plant was 600 tons per day and that it was operated by 15 to 20 men.

Delta Placer Gold Company. Location: N $\frac{1}{2}$ sec. 10, T. 5 N., R. 9 E., M.D.M. (projected), on the Arroyo Seco land grant, for about 2 miles along Jackson Creek. Ownership: Glen O'Brien, Ione, California.

Tailings from the mines around Jackson, including the Zeila, Argonaut, and others, were diverted into Jackson Creek before enactment of the anti-debris or Caminetti Law of 1893. During the winter time, the high waters of Jackson Creek transported and redeposited the tailings in Jackson Valley to an average depth of $2\frac{1}{2}$ feet, although in some places, the depth was 8 feet.

The Delta Placer Gold Company began operations at the present location in 1935 and continued without interruption until 1942. One million three hundred and fifty thousand tons of redeposited tailings were treated with a recovery exceeding 80 percent, the owner reported. Gold assays varied from 80 cents to $2.00 per cubic yard in gold values. The property has been idle since 1942.

The material was bulldozed and conveyed to a pulper and wet-screened with a Symons vibrating 10-mesh screen. The oversize was discarded while the minus 10-mesh material was pumped a maximum distance of two miles to be classified into sands and slimes. Leaching of the sands was accomplished by cyanidation while the slimes were directed to a Dorr agitator where gravity separation of the gold was effected. The slimes were run through a counter-current decantation process and the residues discarded. Eighteen men were employed by the company.

During the stripping of the re-deposited tailings, approximately 220 acres of farming land were reclaimed along Jackson Creek. Discarded material was used to construct a levee on Jackson Creek.

FIGURE 13. Delta Tailings Company, 1936. *Photo by Glen O'Brien.*

Kennedy Tailings. Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 16, T. 6 N., R. 11 E., M.D.M., at the Kennedy mine north of Jackson. Ownership: Mark and Frances Eudey, Martell, California.

In 1948 and 1949, for a period of $1\frac{1}{2}$ years, the Kennedy mine tailings were worked intermittently by Frank Fuller, Jr., of Jackson, who reported that approximately 20,000 tons of gold-bearing tailings were treated with an average recovery of $2.00 per ton.

Fines from the trommel were jigged, run over vibrators, jigged again, and passed over Wilfley tables to recover the fine gold. One to three men operated the washing plant.

Plymouth Tailings. Location: sec. 11, T. 7 N., R. 10 E., M.D.M., at the site of the Plymouth Consolidated mine. Ownership: B. Monte Verda and E. C. Taylor, Box 367, Jackson, California.

During the period from 1939 to 1943, the Argonaut Mining Company, which then owned title to the Plymouth Consolidated mine, operated a flotation and cyanide plant to process Plymouth mine tailings. This plant had a capacity of 500 tons per 24 hours. Tailings were run through a sand pump, screened, flumed to agitators, and then to flotation cells. Concentrates were then shipped to the smelter. Flotation tailings were classified, cyanided by leaching, and gold was precipitated in tanks. About 750,000 tons of tailings were treated in this plant.[10]

Placer Gold

The gold of Amador County placers originated in quartz veins deposited deep in the Bedrock series of the Sierra Nevada. The gold was liberated from these veins by prolonged erosion of the roof rocks and by disintegration of the wall rocks, chiefly under unusual conditions of chemical decay. Gold, one of the relatively indestructible minerals, be-

[10] Logan, C. A., unpublished report, 1948.

came intermingled with other weather-resistant material in streams and was concentrated by action of running water. Owing to its great weight gold tends to accumulate at or near the base of such deposits.

Although there are river gravels of many different ages in the Sierra Nevada, not all of them contain gold in paying quantities. The conditions under which the economic deposits formed are discussed in another part of this report under Geologic History. Several distinct types of river gravel deposits can be recognized:

1. Eocene ("Tertiary") gold-bearing gravels typified by an abundance of white quartz and a paucity of volcanic debris (excepting old metavolcanics). These are almost always found in remnants of channels worn directly into crystalline bedrock or on terraces adjacent to such channels. They commonly are overlain by white rhyolite ash.
2. Inter-rhyolitic channel gravels (Miocene) containing abundant light-colored rhyolitic debris as well as white quartz, but no dark-colored andesitic debris. These commonly are found in channels cut into Eocene gravels or even in channels cut into rhyolite ash. These tend to be much less productive of gold than the Eocene gravels although they occasionally robbed rich Eocene channels and themselves became locally productive.
3. Inter-andesitic channel gravels (Mio-Pliocene) containing abundant andesite debris as well as debris of all older rocks. The chances of these gravels being rich in gold are slight. They may occur by themselves or in super-position above inter-rhyolitic and Eocene deposits.
4. Recent stream gravels consisting predominantly of abrasion-resistant rocks of all types. These may be rich in gold in streams that drain areas where quartz veins are being actively eroded or in areas favorable for re-concentration of materials from older gravels. They are always found along or close to present-day streams.

Associated with gold in placer deposits are heavy mineral grains which are also resistant to chemical and mechanical destruction. These grains, commonly grouped under the heading of black sands, consist essentially of magnetite with varying amounts of ilmenite, rutile, platinum group metals, zircon, chromite, garnet, and other heavy, weather-resistant minerals.

Garibaldi Dredge. Location: SE $\frac{1}{4}$ sec. 23, T. 7 N., R. 12 E., M.D.M., $\frac{1}{2}$ mile east of Volcano. Ownership: Frank and Peter Garibaldi of Volcano.

This property, located at the junction of Pioneer and Sutter creeks, has been worked intermittently since 1940 by the owners. Mr. Frank Garibaldi reports that the stream gravels range from 5 to 15 feet in thickness and rest on a bedrock of Calaveras limestone.

In the process of working an area of ground, the topsoil is first bulldozed to one side. The gravel is then delivered by dragline to a track-mounted washing plant which has a capacity of 40 cubic yards per hour. It is equipped with a 28-foot trommel and a 50-foot stacking boom. Gold recovery varies from 10 to 20 cents per yard. After an area has been worked the gravel piles are leveled and the topsoil is then bulldozed over the gravel.

Lilly Dredge. Location: sec. 24, T. 8 N., R. 9 E., and secs. 20, 28, and 29, T. 8 N., R. 10 E., M.D.M., $5\frac{1}{2}$ miles northwest of Plymouth on the Cosumnes River. Ownership: dredge owned by E. L. Lilly, 1640 East Poplar Street, Stockton 5, California.

From September, 1938, to August, 1942, and again from July, 1946, to November, 1949, gold-bearing gravels on the Cosumnes River were

worked by the Lilly dredge. The pay gravel has been worked for a distance of 3½ miles along the river from the southeast corner of sec. 25, T. 8 N., R. 9 E., to the northwest corner of sec. 28, T. 8 N., R. 10 E., M.D.M. Approximately 2,125,000 cubic yards of gravel averaging 18 cents in gold per yard were handled, according to Mr. Lilly.

Gravel was delivered by a model 85 Northwest dragline having a 2½-yard bucket to a Bodinson floating washing plant. The washing plant, powered by a diesel electric generator, was equipped with 52″ x 32′ trommel, Hungarian riffles set in sluices, and a 70-foot stacking belt. Gold was melted into bars in the cleanup house and sent to the mint.

Madrill Dredge. Location: sec. 1, T. 4 N., R. 9 E., M.D.M., on the north side of the Mokelumne River 5 miles southwest of Buena Vista. Ownership: C. R. and Annabelle C. Brown, R. F. D., Ione, California.

In the spring of 1952 operations were begun by George Madrill to work terrace gravels along the Mokelumne River with a floating dragline dredge. The gravels average 20 feet in thickness and are about 65 feet above river level.

Gravel is delivered to the washing plant by a dragline suspended from a 100-foot boom mounted on the dredge. The dredge is equipped with a 72-inch trommel, a 50-foot stacking boom, and a 460-horsepower diesel-electric power plant. Capacity is 150 cubic yards per hour, according to George Madrill.

Pigeon Drift Mine. Location: SW ¼ sec. 28, T. 8 N., R. 11 E., M.D.M., one mile northwest of Fiddletown. Ownership: Fred N. Pigeon, Fiddletown, California.

Work was first started on the Pigeon drift mine during the 1850's. Intermittent operations by the Pigeon family continued until 1935. At that time the property was leased to F. W. Nowell who operated it until 1942. It has been idle since then except for some re-timbering done by Harry Gould of Sacramento after World War II. From 1935 to 1942, $18,000 in gold was produced, according to Mr. Pigeon.

This deposit consists of a northeast-striking Tertiary stream channel of cemented sands and gravels capped by Tertiary andesites. The channel which lies on a bedrock of Calaveras slates varies from 20 to 50 feet in width and is about 6 to 8 feet in depth. Assays average about $3.00 per cubic yard.

The workings consist of a 300-foot southeast-trending adit driven into the channel and several hundred feet of drifts within the channel. The cemented gravel was crushed, run through a trommel, washing plant, and a sluice box.

Secor Dredge. Location: S½ sec. 18, T. 7 N., R. 12 E., M.D.M., four and one-half miles southeast of Fiddletown. Ownership: Elmer Evans, c/o Treasurer's Office, Jackson, California.

Mr. H. R. Secor of Los Angeles has been intermittently working the property on a royalty basis since the summer of 1951. Placer gold is recovered by means of a dryland dredge.

This deposit consists of well-cemented Tertiary auriferous gravel which ranges from a few inches to four feet in thickness, overlying a greenstone bedrock.

A ½-yard dragline delivers the gravel into a 3- by 6-foot trommel. The undersize falls into a mechanical double rocker, over riffles and into

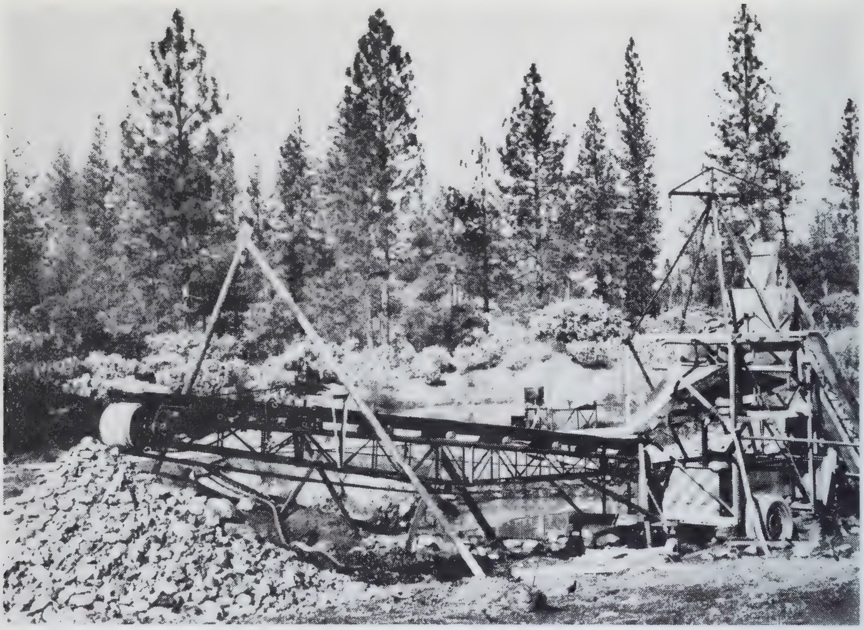

FIGURE 14. Secor placer near Fiddletown. *Photo by Mary Rae Hill.*

a quicksilver sluice. Capacity of this washing plant is 100 yards per day, according to Mr. Secor.

Iron

Although there has been no recorded production of iron ore from Amador County, deposits of low-grade iron occur as irregular patches and cappings in the western part of the county, particularly in the Ione district. Some work was done on the Thomas iron deposit in mid-1952 but no other deposit in the county has been developed.

The largest known deposit occurs on Rancho Arroyo Seco 3 miles southwest of Ione in secs. 27 and 28, T. 6 N., R. 9 E., M.D.M. (projected). Limonite and some hematite act as cementing agents in sandstone of the Ione formation. A number of patches in both sections occur as cappings on small knolls. The largest outcrop has a width of about 300 feet from east to west, and a length of about 1100 feet north to south. The thickness indicated by several exposures where a little digging has been done is only about 2 feet. A general sample gave on analysis: 34.82 percent iron, 0.211 percent phosphorous, 18.5 percent silica, 0.05 percent manganese, and 0.066 percent sulfur.[11]

In the Clinton peak area, SE $\frac{1}{4}$ sec. 8 and SW $\frac{1}{4}$ sec. 9, T. 6 N., R. 12 E., M.D.M., 2 miles southwest of Pine Grove is another iron deposit. This material also occurs as a capping and consists of dark brown limonite with some hematite. The average of two samples taken from a road cut was 27.78 percent iron, 0.150 percent phosphorous, 39.88 percent silica, 0.05 percent sulfur, and 0.90 percent manganese.[12]

[11] Logan, C. A., unpublished report, 1949.
[12] Logan, C. A., unpublished report, 1949.

Thomas Iron Deposit (Anderson Lease). Location: NW $\frac{1}{4}$ of SW $\frac{1}{4}$ sec. 16, and in NE $\frac{1}{4}$ and SE $\frac{1}{4}$ sec. 17, T. 5 N., R. 10 E., M.D.M. This property comprises a total of 197 acres north of the Buena Vista-Pardee Dam Road, a mile southeast of Buena Vista. Ownership: George M. Thomas of Jackson, owner of the property leased it to William Anderson on May 13, 1952.

The deposit consists of flat-lying beds of limonite, and lateritic sands and clays of the Ione formation. Several holes drilled to a depth of 18 feet by the H. Earl Parker Company of Marysville, revealed a limonite capping ranging from 2 to 15 feet in thickness.

William Anderson contracted with the H. Earl Parker Company of Marysville to conduct preliminary mining operations. The company worked about 10 days drilling, bulldozing, and clearing brush, and then removed all of their equipment from the property. The original plans were to ship the iron ore to Japan, according to the owner. The property is now idle.

Manganese

The war years 1914-1918 initiated the exploitation of manganese deposits in Amador County. This exploitation ceased in 1919 and was revived by the stimulating effects of World War II. During World War II, the federal Metals Reserve Company bought and stockpiled manganese ore. Between 1919 and 1942 and since 1944, there has been no recorded production of manganese from this county.

For additional information regarding manganese in Amador County, the following references are suggested:

Bradley, W. W. Huguenin, E., et al., 1918, Manganese and chromium in California: California State Min. Bur. Bull. 76, pp. 29-30.

Jenkins, O. P., 1943, Manganese in California: California Div. Mines Bull. 125, pp. 75, 102-103.

Trask, Parker D., 1950, Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, pp. 27-35.

Manganese in Amador County was originally deposited with silica as a chemical sediment, either as a manganiferous silica gel or as a carbonate if sufficient carbon dioxide was present. The manganese is associated with the rocks of the Calaveras (Paleozoic) and Amador (Jurassic) groups. Taliaferro (1943, p. 331) states that the source of both the manganese and the silica was submarine springs having a volcanic source rather than from the leaching of volcanic rocks. Rhodochrosite and bementite were the original ore minerals deposited. Subsequent metamorphism altered some of the original material into rhodonite while continued weathering oxidized the earlier formed manganese minerals into black manganese oxides.

Manganese is distributed through the western portion of Amador County. The manganese ore consist of pods, lenses, or disseminations of oxides and rhodonite in recrystallized chert of the Calaveras series. Most of the deposits are east of the Mother Lode. West of the Mother Lode, a few deposits occur in metachert that is associated with the metavolcanic rocks of the Amador group. Other deposits are concentrations of low-grade manganese oxides in lateritic soils beneath Tertiary lava caps, while still others consist of beds of manganiferous and ferruginous chert in slate.

Lubanko Prospect. Location: SE $\frac{1}{4}$ sec. 10, T. 7 N., R. 11 E., M.D.M., about 3 miles southeast of Fiddletown. Ownership: Louis Lubanko, Fiddletown, California.

Dr. J. T. Stacy of Pine Grove leased this property during World War II. A few truck loads of manganese ore were mined and shipped as part of a shipment from the Stirnaman mine.

Lenses of psilomelane and pyrolusite, one to three feet thick, occur in massive metachert. These lenses grade into low-grade ore. An ore body 80 feet in length has been exposed by development work. According to Trask, (1950, p. 31) the small amount of ore which was shipped averaged 52 percent manganese, 3 percent iron, and 4.5 percent silica.

The development work consists of two fairly large cuts and two small adits. This property has been idle since World War II.

Perini (Peyton et al. Lease) Mine. Location: NW $\frac{1}{4}$ sec. 35, T. 7 N., R. 12 E., M.D.M., 2 miles east of Pine Grove. Ownership: Benjamino Perini, Pine Grove, California.

Less than one carload of manganese ore was mined and shipped during World War I (Trask, 1950, p. 32). During World War II, the property was leased to the Garibaldi Brothers and Frank Simpson of Volcano who mined and shipped several carloads of ore of unknown grade.

One large cut on the sidehill adjacent to the shaft exposed pockets of psilomelane with some pyrolusite and rhodonite enclosed in an 8-foot wide band of manganiferous metachert of the Calaveras formation. This same cut exposes a zone of 10 feet containing manganese minerals; the zone has a steep dip to the east and a general northerly strike.

The ore now exposed would probably average about 20 percent manganese, but pockets of ore containing 40 percent could probably be found (Trask, 1950, p. 32). A 25-foot gallows frame stands over a shaft 74 feet deep. On the 40-foot level a 25-foot crosscut has been driven to the east. There are extensive bulldozing cuts on this property. A quarter of a mile south of this main shaft is another small shaft.

Peyton (Crocker-Preston) Prospect. Location: SW $\frac{1}{4}$ sec. 15, T. 7 N., R. 12 E., M.D.M., about 2 miles east of Pine Grove. Ownership: Benjamino Perini, Pine Grove, California.

During World War I, 30 tons of manganese ore was shipped from this property. In 1943 and 1944, Crabtree, Sullivan, and Stewart of Jackson shipped some ore to the Metals Reserve Company's stockpile in Auburn.

The manganese ore, chiefly psilomelane and pyrolusite, occurs as pods and lenses in massive metachert which is enclosed in a weathered quartz-sericite schist. The general structure strikes N. 23° and dips 65° northeast. In 1940, E. A. Kent was contracted to diamond drill this property. Although several stringers of rhodonite were encountered by seven 85-foot drill holes, no commercial ore bodies were discovered.

Mining workings consist of two small 15-foot, partially caved shafts and two large bench cuts as well as extensive surface bulldozing.

Stirnaman Mine. Location: SE $\frac{1}{4}$ of sec. 24, T. 7 N., R. 12 E., M.D.M., between Pioneer Station and Pine Grove. Ownership: J. L. and L. C. Wells, 716 Wagner Avenue, Stockton, California.

During World War I, 250 tons of manganese ore were shipped from this property. Dr. J. T. Stacy of Pine Grove leased and mined the prop-

erty during 1942 and 1943 and shipped some ore to the Metals Reserve Company in Sacramento. This property has been idle since 1943.

The manganese ore, chiefly psilomelane, occurs as lense 1 to 8 feet wide in a belt 30 to 50 feet wide of massive metachert which is enclosed by quartz-sericite schist. The general strike is N. 30° E. and the dip is about 60° southeast. One shipment during the fall of 1942 ran 52 percent manganese, 3 percent iron, and 4.5 percent silica (Trask, 1950, p. 35).

Development work consists of some small and large open cuts, two main levels of stopes, and surface bulldozing.

Platinum Group Metals

From 1904 to 1923 the American Dredging Company, which operated three gold dredges on the Mokelumne River, produced from 20 to 25 ounces of platinum group metals per year (Logan, 1927, p. 201). From 1923 to 1942 minor amounts were produced intermittently as a by-product of gold-dredging operations. Of the metal produced, the platinum content was about 50 percent and the remainder was chiefly osmiridium (Logan, 1927, p. 201).

Platinum occurs alloyed with related precious metals in smooth thin flakes or as rounded nuggets in placer deposits in the Sierra foothills. The proportion of platinum metals to gold is nearly always small. Primary platinum is believed to be deposited by magmatic processes in basic or ultrabasic rocks.

NON-METALLIC MINERALS

Asbestos

There are two distinct varieties of asbestos: chrysotile, a variety of serpentine, and amphibole asbestos, which includes several fibrous minerals such as tremolite and actinolite. In Amador County both amphibole and chrysotile asbestos occur in or near massive serpentine bodies.

In Amador County 10 tons of asbestos was produced in 1908 and 2 tons was produced in 1909. Since that date there has been no recorded production, although some intermittent development work on several prospects has proceeded. At the present time, George Thomas of Jackson is developing an amphibole asbestos prospect in sec. 34, T. 6 N., R. 11 E., $1\frac{1}{2}$ miles southeast of Jackson.

Amphibole asbestos occurs in irregular veins along a serpentine-amphibolite contact in the NE $\frac{1}{4}$ sec. 20, T. 6 N., R. 10 E., $2\frac{1}{2}$ miles northeast of Ione (Logan, 1927, p. 134).

Coal

Amador County coal (lignite), although generally low grade in terms of fuel value as compared with bituminous and anthracite coal, commonly has properties which make it valuable for other purposes. In western Amador County, coal (lignite) is found solely in the Ione formation of middle Eocene age where it is associated with beds of clay and sand.

Lignite beds in the Ione region in Amador County were mined for local use early in the 1860's (Goodyear, 1877, p. 79). Intermittent production from this area continued until 1888, and from this time until 1902, substantial amounts of coal were produced. However, from 1902

FIGURE 15. American Lignite Products Company montan wax extraction plant, Buena Vista. *Photo by Mort D. Turner.*

FIGURE 16. American Lignite Products Company open-pit coal mine. Coal bed is about 12 feet thick. *Photo by Mort D. Turner.*

until 1947, there was only sporadic production of coal due to competition from petroleum.

It was not until 1947 that coal mining in this county began again, and then not for fuel purposes. In the late 1940's the lignite was found to contain a high percentage of wax suitable for industrial purposes providing an economic means of extraction could be developed. Profitable extraction methods have since been developed and montan wax and other industrial waxes have been produced. Now Amador County deposits make the United States self-sufficient in montan wax (Sawyer, 1949), which was formerly imported from Germany. Montan wax is similar to carnauba wax and is used in carbon paper, phonograph records, polishes, and rubber.

American Lignite Products Company (Western Division of De Angelis Coal Company of Carbondale, Pennsylvania). Location: The plant is located approximately 6 miles south of Ione, near Buena Vista, in NE $\frac{1}{4}$ of sec. 19, T. 5 N., R. 10 E., M.D.M. The company owns 1800 acres in Ione including the Buena Vista coal mine in E $\frac{1}{2}$ sec. 19, T. 5 N., R. 10 E., M.D.M. J. N. De Angelis is plant superintendent of the company and F. J. De Angelis is the general manager.

Operation began in early 1947 with the erection of a pilot plant for the extraction of montan wax from lignite. The first commercial production occurred in April, 1948, after about a year's intensive experimental and research work. A serious fire in the fall of 1948 completely destroyed the pilot plant. A second pilot plant was completed in early 1949, only to be destroyed in 1949.

Construction of a larger extraction plant was completed during February of 1950. This plant averaged approximately 50,000 pounds each month until September of 1951 when a new process was installed. Work was completed during February of 1952. Different types of wax are produced, with a combined average of approximately 130,000 pounds per month, according to F. J. De Angelis.

Lignite occurs interbedded with the nearly flat-lying clay and sandstone beds of the Ione (Eocene) formation. According to the company's drill hole results, the lignite beds are lenticular-shaped bodies with a maximum diameter ranging from 500 to 3000 feet. The lignite seams range in thickness from about 1 foot at the outside edge of the lens to an approximate maximum thickness of 14 feet. The thickness of the overburden already encountered in stripping operations varies from 15 to 25 feet.

Strip-mining of the lignite beds is accomplished by an 85-foot boom dragline. The dragline bucket has a $2\frac{1}{2}$-yard capacity and can handle about 800 tons of lignite per day. The conventional procedure used from strip mining is to recover the lignite along the edges of the deposit and work towards its center. End-dump trucks then transport the material to the extraction plant.

Lignite from the mine is conveyed to a hammer mill equipped with air separation equipment after having been crushed by the toothed crusher. The crushed material is fed into a hammer mill while the outgoing 200-mesh material is fed in weighed quantities to extractors where petroleum solvents remove waxes, organic salts (esters), and resinous and asphaltic substances.

FIGURE 17. Strip mining at American Lignite Products Company pit.
Photo by Mort D. Turner.

The heavy material or "bottoms" from the centrifuge is directed into stills and finally to the dump. The light liquid or effluent passes through filters and into the distilling towers where montan wax is extracted by steam distillation. The wax is drained from the bottom of the still kettle into cooling pans, then to bags for shipment.

The plant is operated on a 24 hours per day, seven days per week schedule by 28 men. In addition, two chemists are employed in the company laboratory to insure quality control of the montan wax.

Humacid Company Coal Mine. Location: SW $\frac{1}{4}$ sec. 29, T. 5 N., R. 10 E., M.D.M., about $2\frac{1}{2}$ miles south of Buena Vista in China Gulch. Ownership: The Humacid Company of Los Angeles has leased the property from B. F. Wellington, owner.

Although the lignite beds fluctuate locally somewhat in attitude, they occur essentially as flat-lying beds interbedded with Ione sands and clays. Small 1- to 2-inch clay beds occur in the lignite 2 to 3 feet apart. Samples cut by the company in the lignite beds revealed that the wax content is higher towards the bottom of the beds, the best material averaging 16 percent, according to W. C. Kreth, superintendent. Fossil plant remnants are a common occurrence at the tops of the beds. Preparatory to development and mining operations, four vertical test drill holes 200 feet apart on an east-west line were drilled to prove the dimensions of the lignite beds.

In 1951, the company began to sink a circular, vertical shaft 5 feet in diameter. The shaft, which is cased with a steel liner, is now 80 feet deep with one mining level entirely within the lignite at the 75-foot mark. On the 75-foot level, the operators have drifted 100 feet east, and then 100 feet north and 8 feet west, and then 100 feet north. Most of these underground workings are timbered. Continued drifting on the

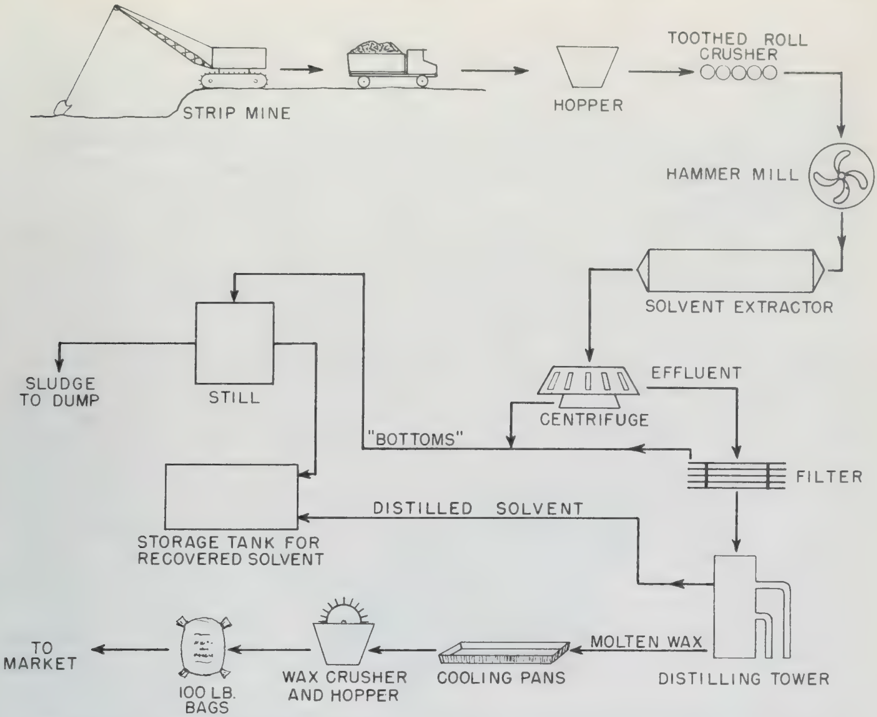

FIGURE 18. Generalized flow sheet showing recovery of montan wax from lignite. *After American Lignite Products Company plant.*

east drift and the north drift off the east drift is now underway. Future plans are to use the room-and-pillar method of mining.

The mine is lighted by incandescent lamps. A converted electric hoist powered by a Ford Model A gasoline engine lifts the circular cage in conjunction with a cement-mounted, 24-foot, welded steel headframe. Drilling is accomplished by four-foot, electric auger drills.

After blasting, the lignite is hand mucked into an ore car with an 1100-pound capacity, hand-trammed to the station, and loaded aboard the circular cage. The cage is then hoisted to the surface where the ore is again hand-trammed and the lignite deposited into a storage bin. The ore is then hauled about 3 miles to the company's plant by truck.

In late 1951, the mine produced 25 cars of ore per day for processing in the company's industrial wax plant. W. C. Kreth, superintendent, and two men operate the mine.

The Humacid Company is now in the process of erecting a plant to extract industrial waxes.

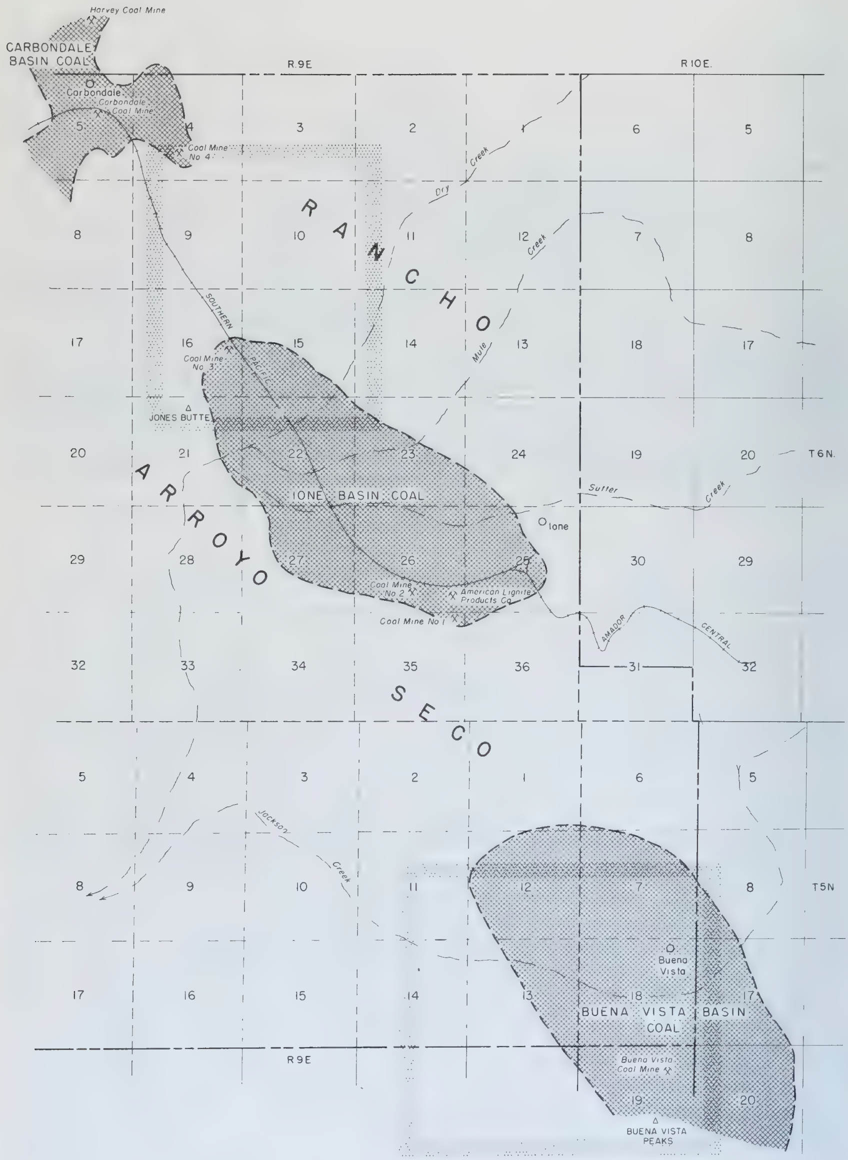

FIGURE 19. The coal basins of Amador County. Boundaries are fairly definite for the east and west sides of the Buena Vista Basin, the south side of the Ione Basin and the portion shown of the Carbondale Basin. Other boundaries are approximately located. (Modified by Mort D. Turner from unpublished maps by Mocine, 1923, and McCready, 1927.) Areas within stippled borders are described in California Journal of Mines and Geology, July 1949, and in California Division of Mines Special Report 19.

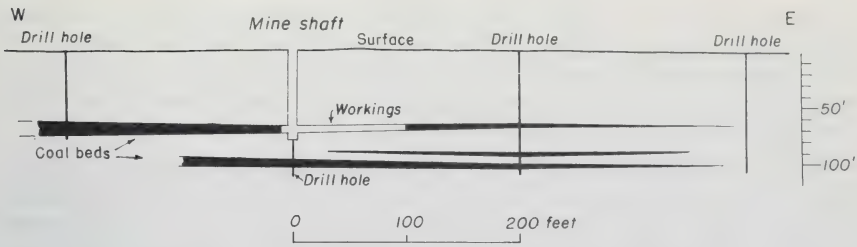

FIGURE 20. Cross-section of Humacid Coal Company mine.

Crushed Rock, Sand and Gravel

Granodiorite, granite, and associated granitic rocks occur in the eastern part of Amador County. Broken and crushed granite is produced intermittently for use as road metal and fill. Coarse residual sand originating from the weathering of granite has been used in road repair and construction.

Riprap composed of broken granodiorite was used in the construction of the roads owned by the Pacific Gas and Electric Company east of the West Point Power House. In 1951 a portable crushing plant operated by A. R. Milton produced crushed granite for use as road metal by the Amador County Road Department. Coarse sand originating from weathered granite has been produced by the Amador County Road Department from a pit in sec. 1, T. 6 N., R. 11 E., M.D.M., on the New York Ranch.

Sand and gravel deposits are largely stream-laid accumulations of sand, gravel, cobbles, and boulders. The deposits are usually poorly-sorted, imperfectly stratified, and elongated in the direction of stream flow.

As the drainage pattern of Amador County is essentially westward and most of the rock formations strike northwest, its rivers, streams, and tributaries cut across many different rock types. The sand and gravel deposits are derived from rocks resistant to weathering. The resistant rock types consist chiefly of chert, metachert, greenstone, metavolcanic rocks, quartz, and granitic rocks. They are intermittently prepared and utilized as road metal and fill.

Exact production figures for sand and gravel in Amador County over the years are not available as this information is included in a miscellaneous category. However, during 1947, 34,490 tons of sand and gravel worth $65,476 was produced in the county (Jenkins, 1950, p. 42). Since that time, only small, intermittent production has been recorded.

Alpine Gravel Plant. Location: NE $\frac{1}{4}$ of SW $\frac{1}{4}$ sec. 22, T. 6 N., R. 11 E., M.D.M., about 1 mile east of Jackson on Jackson Creek. Ownership: the plant is owned by Jack Bacigalupi, Pine Grove, California.

Jack Bacigalupi and Orville Youmans, both of Pine Grove, leased and worked the property from 1945 to June of 1951. During this time, the operators produced minus $\frac{3}{4}$-inch crushed rock for various contractors for use in concrete. The average production of the gravel plant was about 50 cubic yards per day, according to Mr. Bacigalupi.

Between 1946 and 1947, the operators recovered some gold by diverting the creek gravel through a dragline dredge before running it through the gravel plant. Jack Bacigalupi stated that the enterprise was not particularly successful as the gold content ran between 17 and 20 cents per cubic yard. The dredge is now idle.

Relvas Gravel Deposit. Floyd O. Bailey, general contractor of Madera, California, has a contract with Sacramento County to produce 1¼-inch road ballast from the old placer tailings on Dry Creek, about 2 miles northwest of Ione in secs. 14 and 15, T. 6 N., R. 9 E., M.D.M. (projected). The tailings piles are leased from E. J. Relvas, Ione, California. Three men operate a Twin-dual master 24 Universal portable crusher to produce about 1500 tons of crushed rock per day. The 1¼ inch material is stockpiled and used as needed by Sacramento County, Amador County, and the State of California.

Sacramento County Sand and Gravel Pit. Location: SW ¼ sec. 5, T. 7 N., R. 9 E., M.D.M., on Arkansas Creek just north of state highway 16, approximately 2 miles east of Michigan Bar. Ownership: Louis G., Cora J., and Gene L. Klotz, Freeport Boulevard, Route 8, Box 1380, Sacramento 17, California.

During 1951, this property was worked by the Sacramento County Highway Department. At that time, 7000 tons of crushed rock were produced from cobbles and coarse gravel and used as road metal. Sacramento County again commenced mining operations during the middle of June, 1952, producing sand. In the fall of 1952, 9000 tons of crushed rock were produced. This deposit is worked at irregular intervals to supply material for building and repairing roads in the eastern part of Sacramento County. The sand consists almost entirely of quartz.

Mining equipment includes a P & H gas-powered truck-mounted crane with a 30 foot boom and a ½-cubic yard clamshell bucket, a bulldozer, and several end-dump trucks.

The production of sand is intermittent depending upon the needs of the county. Two men operate the sand pit.

Dimension Stone

Rhyolite Tuff

Rhyolite, a fine-grained volcanic rock composed predominantly of light-colored feldspars and quartz, is occasionally utilized as dimensional stone. One such deposit in Amador County is the Evans deposit in the center of sec. 18, T. 7 N., R. 12 E., M.D.M., and extending to the northeast in sec. 17, T. 7 N., R. 12 E., M.D.M.

This material is a well-compacted rhyolite tuff varying in color from white to buff. During the 1880's and 1890's, rhyolite from this deposit was quarried as a building stone for various buildings in the county, according to Elmer Evans, Jr., the owner.

Sandstone

Appreciable quantities of sandstone were produced in Amador County prior to 1914. Since that date only minor amounts have been produced intermittently. This early production was largely dimension stone for use in building construction.

In the 1880's and 1890's, sandstone for dimension stone purposes was produced from a quarry in sec. 27, T. 5 N., R. 10 E., about 8 miles

south of Ione. Even, fine-grained sandstone with a pleasing bright red color was produced from several quarry faces 15 to 20 feet high. Stone from this quarry was used in the construction of the Preston School of Industry in Ione, the California Bank Building in Sacramento, and the old Chronicle Building in San Francisco (Aubury, 1906, p. 117). Pure white sandstone having somewhat lower crushing strength than the red material may also be found in the quarries.

Serpentine

Small amounts of serpentine were produced in Amador County in the 1880's and 1890's for use as ornamental building stone. A yellowish-green to dark olive-green serpentine was quarried 2 miles west of Plymouth while a mottled variety of serpentine was quarried 1½ miles west of Sugar Loaf in the vicinity of Waits Station (Aubury, 1906, p. 147).

Slate

In 1941, G. J. Alexander of Amador City produced slate from a quarry near Martell. About 1900, some preliminary work was done on a slate quarry 1½ miles east of Ione. Except for these operations, there has been little production.

Slate is used primarily as roofing granules and slabs, flagstone, table tops, blackboards, insulating material, and as mineral filler (Turner, 1950, p. 259). Most of the slate in Amador County is found in the Mariposa formation, which occurs in broad belts in the western part of the county.

Gems

Diamonds have been found in gold-placers in the Sierra Nevada foothills in Amador County. As yet no primary deposits have been discovered but the placer diamonds are believed to have originated in the ultra-basic igneous rocks from which the serpentine masses were derived.

Between 60 and 70 small diamonds have been found in Jackass Gulch near Volcano. The larger stones ranged from 1 to 1.57 carats in weight (Murdock and Webb, 1948, p. 30). Four small octahedral diamond crystals found near Volcano were placed on display in the American Museum of Natural History, New York City (Kunz, 1905, p. 41). A few small diamonds have also been found in Indian Gulch near Fiddletown. In 1934, a 2.65 carat diamond was found near Plymouth (Sperisen, 1938, p. 39).

Several varieties of chalcedony and opal occur in Amador County, although there is no recorded production of these commodities. Chrysoprase (apple-green chalcedony), occurs as seams in altered serpentine 6 miles southeast of Ione in sec. 34, T. 6 N., R. 10 E., M.D.M. Chrysoprase also occurs in veins and as replacement pods in silicified serpentine 1 mile south of River Pines east of the Pigeon Creek School. Small amounts of blue chalcedony occur in the vicinity of Volcano (Pabst, 1938, p. 96).

Moss opal is found three-quarters of a mile south of River Pines associated with siliceous limonitic serpentine. Opalized weed has been found near Volcano (Pabst, 1938, p. 99).

Limestone-Marble

Lime (CaO) and limestone ($CaCO_3$ + impurities), two closely allied materials, are the basis of a multimillion dollar business in California

(Bowen, 1950, p. 171). Most lime is produced by calcining limestone. The largest consumer of lime is the portland cement industry which requires a high-calcium limestone. Much lime is also used in mortar, plaster, and stucco.

Other important uses of limestone are in agriculture as soil additives, in the steel industry as a basic flux in furnaces, in the beet sugar

FIGURE 21. Old building in Volcano, constructed of limestone quarried locally. *Photo by Mary Rae Hill.*

industry to remove impurities from the raw beet juice, and in the manufacture of industrial chemicals.

Total production of lime and limestone from Amador County has not been recorded (Logan, 1947, p. 207). Between 1904 and 1915 production of lime averaged 1100 barrels per year. Since 1915 little or no limestone has been produced except in 1945 from the Allen property.

In 1894 almost 26,000 cubic feet of marble were produced. From 1895 to 1905 marble production averaged slightly more than 4000 cubic feet per year. Since 1905 only small amounts of marble have been produced intermittently from the Dondero quarry.

Limestone lenses in Amador County occur in the Calaveras formation in the western Sierran foothills and farther east near Volcano and Fiddletown. In the west the lenses are numerous but small in areal extent while to the east they are considerably larger, the largest being the Volcano deposit.

The limestone has a north to northwest trend and occurs in lensoid to tabular bodies which stand nearly vertical. Jointing is prominent in nearly all of the deposits. Those in the western foothills and at Volcano are bluish-gray in color and weather to a dull gray. Several of the deposits consist of marble that is white with irregular blue and gray streaks. West of Drytown is a deposit of red marble. Crinoids and corals of Paleozoic age have been found in two lenses on the Allen property south of Sutter Creek.

A series of spot surface samples taken by O. E. Bowen, Jr., and C. R. Nichols at 20-foot intervals on the slope immediately north of Volcano and parallel to the main street was analyzed by Abbot A. Hanks, Inc., to give the following results by percentages:

	Sample Number							
	20	*40*	*60*	*80*	*100*	*120*	*140*	*160*
Insoluble	1.06	1.03	0.38	0.65	1.71	0.68	0.78	0.66
R_2O_3*	0.25	0.16	0.55	0.46	0.20	0.27	0.69	0.14
$CaCO_3$	97.40	97.23	97.06	97.23	95.39	97.21	96.70	96.96
$MgCO_3$	0.20	0.21	0.20	0.92	2.38	1.42	1.13	0.20

* Aluminum and iron oxide.

The following are analyses made by Abbot A. Hanks, Inc. of samples taken from various properties in Amador County:

Allen Estate, 7 miles northeast of Ione; method of sampling unknown.

	Percent
Insoluble	1.60
Ferric and aluminic oxides	0.42
$CaCO_3$	96.90
$MgCO_3$	1.06

Garibaldi Ranch, 2 miles south of Drytown; composite sample across width of 120 feet by C. A. Logan.

	Percent
Insoluble	3.55
Ferric and aluminic oxides	0.30
$CaCO_3$	71.70
$MgCO_3$	24.31

Dal Porto Marble, 2 miles east of Plymouth; composite sample across quarry face by C. A. Logan.

	Percent
Insoluble	5.59
Ferric and aluminic oxides	0.56
$CaCO_3$	90.69
$MgCO_3$	2.04

Fiddletown deposit; composite surface sample by C. A. Logan.

	Percent
Insoluble	0.60
Ferric and aluminic oxides	0.22
$CaCO_3$	95.31
$MgCO_3$	2.98

Grelich Ranch, 8 miles southeast Latrobe; method of sampling unknown.

	Percent
Insoluble	1.00
Fe_2O_3 and Al_2O_3	0.56
$CaCO_3$	97.85
$MgCO_3$	0.41

Allen Limestone Deposit, Teichert Lease. Location: SW¼ sec. 13, T. 6 N., R. 10 E., M.D.M., 2½ miles southwest of Sutter Creek. Ownership: George Allen, Sutter Creek.

A. Teichert and Son leased this property in 1945 and shipped 5000 tons of limestone for use as sugar rock. The fines were sold as road rock. This property has been idle since 1945, according to Lee Gardner.

The deposit consists of a limestone lens approximately 100 feet wide and 400 feet long. The limestone is bluish-gray, fossiliferous, prominently jointed, and strikes northwest.

The limestone was handled by power shovels, crushed, sized by a multi-deck trommel, and shipped by truck. There was no equipment on the property late in 1952.

Dondero (Carrara) Marble Quarry. Location: N½ sec. 29, T. 7 N., R. 12 E., M.D.M., 2¼ miles west of Volcano. Ownership: Aurelio G. Dondero, 852 59th Street, Oakland, California.

This property was worked on a modest scale for 30 years until 1933. A quarry floor 150 feet wide with a face nearly 150 feet high was worked (Logan, 1947, p. 209). Large blocks of marble in a rough state were shipped to San Francisco where they were cut and polished. Marble from this quarry was used in the rotunda of the San Francisco City Hall and in the rotunda of the Museum Building at Stanford University (Aubury, 1906, p. 97).

The stone is principally white marble with black streaks, although white and ash-colored marble are also present.

Mineral Paint

In 1918 and 1920 a small production of mineral paint was recorded in Amador County. At many places in the Ione sands and clays, red and yellow iron oxides occur in the form of mineral paint or ochre. Because of impurities and physical properties of most of the deposits, very little ochre has been produced in Amador County.

Roberts Lease. Location: NE$\frac{1}{4}$ sec. 34, T. 6 N., R. 11 E., 1$\frac{1}{2}$ miles southeast of Jackson. Arthur Roberts of Jackson leased the property during World War I for a short period on land that is now part of the Ginocchio estate, according to J. Schweitzer.

The raw material is highly weathered schist. This rock is very friable, fine grained, and some is streaked with white and yellow material. The deposit measures about a half a mile along the strike by about 150 feet wide.

Two carloads of ochre were shipped to the market during World War I, according to Mr. Schweitzer.

Pumice

Fragmental pumice, a frothy volcanic glass, is mined for aggregate at several points in Amador County.

Pumice and a fine-grained pumicite crushed from it are utilized principally as a lightweight aggregate in the construction industry. Other uses are as abrasives, as fillers in paints, paper, and rubber, insecticide carriers, and as filtering aid.

A small production of crushed pumice from Amador County has been recorded each year since 1938, with the exception of the war years, 1942 to 1946.

In 1947 Charles Bacon of Ione began sporadic production of pumice from a deposit in SE$\frac{1}{4}$ sec. 19, T. 6 N., R. 9 E., M.D.M. (projected). This material is marketed principally in Berkeley, California.

This deposit, which occurs in the Valley Springs formation, consists of a bed of white pumicite 10 to 15 feet thick. The bed has a slight westerly dip and is overlain by andesitic detritus of the Mehrten formation. Overburden is absent in places, but may attain 90 feet in thickness in others. Development work consists of an open pit and a short adit.

Quartz Crystals

During World War II the U. S. Geological Survey conducted a quartz-crystal investigation in California. Although there has been no recorded production of quartz crystals thus far from Amador County, the investigation revealed that one of the most promising deposits in California[13] is located near Fiddletown. The crystals are found in

[13] Durell, Cordell, personal communication, 1952.

placer deposits between Dry Creek and Big Indian Creek, northeast of Fiddletown. Sustained economic exploitation of this deposit probably would be attempted only in times of national emergency. During World War II quartz crystals for use in vacuum tube oscillators were in short supply and all known resources were investigated.

The quartz crystal deposits near Fiddletown occur in ancient stream gravels, possibly of upper Eocene age. Most of the crystals are located in close proximity to the bedrock and show very little if any abrasion, indicating that they were transported only a short distance from their source.

Refractory Materials

Clay *

The clay minerals are comprised of three major mineralogic groups, the kaolins, the montmorillonites, and the illites. Kaolin-group minerals are kaolinite, dickite, halloysite, and nacrite, all of which have the ideal formula $Al_2Si_2O_5(OH)_4$. They are distinguished by their internal crystalline structure. Kaolinite is almost always the dominant mineral in commercial deposits of high-grade ceramic clays. Clays of the kaolinite group make up all of the commercial clay deposits of Amador County.

Clays are divisible into two main geological groups; residual (formed in their present position) and sedimentary (transported to their present position from a point of origin elsewhere). Most residual clays are formed by the weathering of materials at or near the surface or, less commonly, by alteration of rock by hot rising mineralized water. The sedimentary clays are derived from residual clays by erosion, usually by running water.

Most of the high-grade fire clays of California are in sedimentary deposits formed in the Paleocene and Eocene epochs. At this time topography was subdued, a large part of the state was covered by shallow seas, and a warm, moist climate prevailed. These conditions caused deep weathering of the land surface and led to the formation of residual clay over large areas. The clays were gradually eroded and deposited in lagoons and deltas. Beds that contain clay deposits of commercial interest are exposed in (1) a narrow, discontinuous belt along the western Sierra Nevada foothills; (2) a horseshoe-shaped belt on the west, north, and east sides of the northern portion of the Santa Ana Mountains, Riverside and Orange Counties; and (3) an area in the northern portion of the Diablo Range, Alameda and Contra Costa Counties. The important production centers are at Alberhill in Riverside County, Ione in Amador County, and Lincoln in Placer County. Amador County ranks third among the counties of California in total fire-clay production and in annual fire-clay production.

The fire-clay deposits of Amador County are contained in the Eocene Ione formation which formed in the shallow sea that bordered the western flank of the ancestral Sierra Nevada. The clay bodies are lenticular and nearly horizontal. Some of the clay-bearing beds have been capped and preserved from erosion by volcanic rock, principally rhyolite and andesite. The Ione formation in Amador County is composed of two members separated by an unconformity (Pask and Turner, 1952).

* This section has been prepared by Mort D. Turner, Assistant Mining Geologist, California Division of Mines.

The lower member of the Ione formation contains most of the commercial clay of the area and is characterized by the rarity of chlorite, biotite, and certain types of clays. In southwestern Amador County, the lower member is divisible into three lentils. The lower lentil contains the Edwin clay—which is mined near the town of Ione—and reworked laterite. The middle lentil contains the lignitic coal beds of the area. The upper lentil contains the Cheney Hill clays and the white Ione sand.

The upper member of the Ione formation is predominantly sandy and contains two mappable units: a hard white sandstone at the top of the member, and the Chitwood clay in the upper part of the member.

The most significant fact so far derived from the geological studies of the Division of Mines in the Ione area is that with only one exception (the Chitwood clay) all of the commercially valuable clays are restricted to the lower member of the Ione formation and to the weathered rock at the base of the Ione. This is of primary importance to any future prospecting for clay in the area. Many useful articles have been published on the geology of the clay-bearing beds of the Ione area and should be consulted by anyone working with clay in Amador County (see Pask and Turner, 1952).

Clay mining in Amador County began at least as early as 1864 with the opening of the Dosch Pit between Ione and Carbondale. However, other pits probably were already active in the Carbondale region by that time. As in other parts of the state, clay was discovered through mining for coal. With coal as a cheap plentiful fuel and good clay readily available it is not surprising that several prosperous potteries were built. At least one was active by 1862 and some were still producing as late as 1906.

As the use of refractory clay gradually overshadowed pottery clay the center of production moved toward Ione until at the present time there is only one active clay pit near Carbondale; all the rest are in the Ione Valley. While a great deal of the Ione clay still goes into heavy clay products, a large part, probably well over half, is used as refractory material. Especially valuable to the economy of the state is the presence of large quantities of Edwin clay in the county. This is a very refractory clay with a P.C.E. * of cone 34 + and therefore suitable for the production of the highest grade of fire-clay bricks.

The following descriptive listing of clay pits only covers those pits which are active now or have been active recently. A much more complete listing is contained in the tabulated list of mineral deposits although this list does not contain some of the old and small pits of which no record has survived.

Airplane Pit. Location: 3 airline miles N. 52° W. of Ione on the north side of the Ione-Sacramento road. The Airplane pit is in lots 222 and 236 of Rancho Arroyo Seco; NW$\frac{1}{4}$ sec. 15, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Streets, San Francisco, leased since 1948 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

* P.C.E. (pyrometric cone equivalent) is a means of designating the refractoriness of a clay by comparison, during firing, to the behavior of a standard set of prepared pyrometric cones. The number is that of the standard pyrometric cone whose tip touches the support simultaneously with the tip of a cone of the refractory material being tested. The testing is done under standardized conditions.

Refractory clay is mined from the upper part of the lower member of the Ione formation. Seven beds have been recognized and called Bacon No. 1 to No. 7. Bacon No. 1 is the thin overburden of soil and contaminated clay. Bacon No. 2, which was formerly produced, has now practically disappeared. Bacon No. 3, a white clay, and Bacon No. 4, a chocolate-colored clay, are mined together and have a combined thickness of 8 to 10 feet. Bacon No. 5 and No. 6 are a light buff color with slightly different appearance but the same physical properties and are mined together. They have a combined thickness of 12 to 15 feet. Bacon No. 7 contains a much higher proportion of iron than the beds above and very little has been mined. Below Bacon No. 7 is a gray-blue sandy clay. Bates (1945, p. 24) classifies the Bacon clays as Eastern Ione type. The general distribution of these clays to the northwest is indicated by Johnson (1948 and 1949).

Clay has been produced from the Airplane pit since about 1930, and during this period the pit has been one of the major sources of refractory clay in the Ione area. Most of the clay produced is shipped by rail to Pittsburg for use in refractories and a small amount is used at Lincoln in heavy clay products. The deposit has been mined entirely by open pit. Stripping and mining are carried out under contract as described under Gladding, McBean and Company.

Cheney Hill Pit. Location: 2 airline miles S. 45° W. of Ione on the north side of Cheney Hill. The Cheney Hill pit is in lots 257 and 258 of Rancho Arroyo Seco; SW¼ sec. 35, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Streets, San Francisco, leased since 1948 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

Cheney Hill clay, one of the several type-clays that crop out over wide areas of the Ione Valley, has been mined at a number of places. The bluish-gray Cheney Hill clay occurs in the upper part of the lower member of the Ione formation. In this pit it has a thickness of about 17 feet, is overlain by as much as 24 feet of brown clayey sand and sandy clay, and is underlain by more clayey sand. The Cheney Hill clay has a P.C.E. of cone 33-34. (Bates, 1945, p. 24.)

The Cheney Hill pit has been worked since the late 1920's and the clay produced used largely in the manufacture of refractories. The deposit has been mined entirely by open pit. Stripping and mining are carried out under contract as described under Gladding, McBean and Company.

Clark Sand Pit. Location: 1.7 airline miles N. 16° E. of Carbondale; SW¼ sec. 28, T. 7 N., R. 9 E., M.D.M. Ownership: Pacific Clay Products Company, Box 145, Station A, Los Angeles 31.

Clayey sand is mined from the Ione Sand bed near the top of the lower member of the Ione formation. The usable material is from 25 to 40 feet thick and is overlain by soil and iron-stained sand up to 4 feet thick. The Ione Sand in this pit contains a higher proportion of sand to clay than is usual in Amador County.

The Clark sand pit was active at least as early as 1906 and there has been intermittent production to the present (Aubury, 1906, p. 208; Tucker, 1914, p. 6; Logan, 1927, p. 136; Dietrich, 1928, p. 261). In the

FIGURE 22. Custer clay pit. West face in bank of siliceous Ione sand and gravel.
Photo by Mort D. Turner.

FIGURE 23. Deutschke pit showing face of Edwin clay. Camera bearing northwest.
Photo by Mort D. Turner.

early 1920's a pilot plant was constructed for the separation of china clay and silica sand. The Ione sand from the Clark pit is used largely for setting sand with small amounts going into terra cotta and white bricks.

The earliest production was from room and pillar stopes but in recent years all operations have been by stripping and open pit operations.

Deutschke Pit. Location: 3.3 airline miles N. 75° W. of Ione; N½ sec. 21, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Charles J. Deutschke, Ione, under lease to Western Refractories Company, Russ Building, San Francisco.

Edwin clay is mined from the Edwin clay bed in the lower part of the lower member of the Ione formation. The bed at this point is about 20 feet thick with very little overburden. The clay is pink to white with a P.C.E. of cone 34 to 34 +. Some red spots, due to presence of iron, have a slightly lower P.C.E.

The Deutschke pit is stripped and then mined by open pit methods. The clay is trucked to the Western Refractories Plant at Ione where it is used in the production of super-duty fire bricks.

Dosch Pit. Location: 2.8 miles N. 52° W. of Ione at the intersection of the Sacramento and Irish Hill roads; N½ sec. 15, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Pacific Clay Products Company, Box 145, Station A, Los Angeles 31.

Flat-lying beds of white to buff refractory clays are mined from the upper part of the lower member of the Ione formation. These clays are similar to the Bacon clays of the adjacent Airplane pit but exact correlation is not readily possible. Two to 4 feet of soil and gravel overlie 10 to 12 feet of Dosch stripping, a clay similar to Bacon No. 2. The Dosch clay below the Dosch stripping is 50 to 60 feet thick, of which the top 20 feet is currently being mined.

The Dosch pit has been worked since 1864 and is the oldest continuously active clay mine in the state. It was operated by N. Clark and Sons of Sacramento, later of Alameda, until 1946. The clay is mined from an open pit by power shovel and trucked to sheds at Clarksona. From Clarksona it is shipped by rail to Stockton and elsewhere for use in a variety of ceramic products.

For references concerning the Dosch pit, consult the tabulated list at the end of this report.

Edwin Deposits. Location: 3.5 miles N. 72° W. of Ione around the base of Jones (Edwin) Butte. The deposits are in lot 240 of the Rancho Arroyo Seco; S½ sec. 16, N½ sec. 21, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Streets, San Francisco, leased since 1944 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

Highly refractory Edwin clay has been mined in four underground mines and four open pits from the Edwin clay bed. The Edwin clay is near the base of the lower member of the Ione formation and ranges up to 12 feet thick. Overlying the Edwin clay are two beds of lignite and a thick bed of Ione Sand. Below the clay is deep red clay derived from the erosion of older laterite. The Edwin clay is the most refractory of the Ione clays with a P.C.E. of cone 34 +.

FIGURE 24. Dosch pit. The Dosch pit was opened in 1864 and is the oldest continuously active clay pit in California. Camera bearing north. *Photo by Mort D. Turner.*

The mining of Edwin clay at Jones Butte started at least as early as 1925 and has been continuous since. Only Edwin Pit No. 4 is now being worked. The clay is shipped by rail to Pittsburg where it is used for the manufacture of fire brick. Stripping and mining are carried out under contract as described under Gladding, McBean and Company.

For bibliographic references concerning the Edwin pit, see the tabulated list at the end of this report.

Farci Pit. Location: 3.1 miles S. 27° E. of Ione; SW$\frac{1}{4}$ sec. 5, T. 5 N., R. 10 E., M.D.M. Ownership: Antoni Farci, Ione, under lease since 1950 to Western Refractories Company, Russ Building, San Francisco.

White clayey sand is mined from the Ione sand bed in the upper part of the lower member of the Ione formation. Material from the Farci pit was used until 1949 in the production of white portland cement. Since then it has gone into the production of fire brick. The deposit was originally worked by room and pillar stoping but all of the later mining has been by open pit. In mining the overburden is stripped off and the Ione Sand loaded with a power shovel into trucks and hauled to the company plant at Ione.

Gladding, McBean and Company. Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26, Fred B. Ortman, President, operate several clay pits in the Ione area of Amador County and control a large number of idle or unexplored clay deposits. In 1948 they leased the clay-mining rights to the 33,276 acre Rancho Arroyo Seco

FIGURE 25. Ione sand pit. Upper bench is cut in overburden, lower benches in white Ione sand. Camera bearing northwest. *Photo by Mort D. Turner.*

which covers most of the Ione-Carbondale clay area. In addition the Ione Red deposit is leased outside of the Rancho.

The various clay pits are stripped and mined under contract. The work usually begins in the spring, after the last heavy rains, with stripping of overburden from the clay bank to be mined that season. The carryall used for stripping is moved from one pit to the next until by the end of the stripping season all of the areas to be worked that year are uncovered. A crew with a bulldozer and a Hough mechanical loader progresses from pit to pit mining that year's supply of each particular clay in a few weeks. A caterpillar tractor with a rooter is used for either stripping or mining as the need arises. In this manner a large number of pits are worked each dry season with a minimum of men and equipment.

The clay is trucked to the nearest railroad siding and either loaded directly onto cars or stockpiled for future shipment. Gladding, McBean and Company do not use any of the Ione clays within the county, but ship them by rail to their plants in Lincoln and Pittsburg. In addition, large quantities are sold.

Ione Red Pit (Bacon Red) (Lane Mottled). Location: 1.5 miles S. 43° W. of Ione on the south side of the Ione-Jackson road; NW$\frac{1}{4}$ sec. 32, T. 6 N., R. 10 E., M.D.M. Ownership: Mrs M. J. Bacon, Ione. Leased in 1948 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

A fine grained, plastic, red and buff mottled clay called the Ione Red or Bacon Red clay is mined from the upper part of the lower member

of the Ione formation. The pit is on the extreme eastern edge of the Ione basin and the Ione Red clay rests directly on highly weathered Mariposa slate. The clay bed ranges from a few feet to 20 feet in thickness and the overburden in places is as thick as the clay bed. The beds have a shallow dip to the west.

The deposit has been worked as an open pit since about 1925. Stripping and mining are carried out under contract as described under Gladding, McBean and Company. The clay is hauled by truck to a nearby siding on the Amador Central railroad where a major proportion is shipped by rail to the Lincoln plant of Gladding, McBean and Company for use in heavy clay products.

Ione Sand Pit. Location: 1.3 miles S. 12° W. of Ione on the west side of the Ione-Stockton road. The Ione Sand pit is in lot 260 of Rancho Arroyo Seco; N$\frac{1}{2}$ sec. 36, T. 6 N., R. 9 E., M.D.M. (projected). Ownership: Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Streets, San Francisco, leased since 1948 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

At the Ione Sand pit Gladding, McBean and Company mine white clayey sand of the Ione Sand bed in the upper part of the lower member of the Ione formation. The overburden is soil and iron-stained Ione sand up to 10 feet thick.

The Ione Sand pit was first operated about 1935 and has been a major source of fire sand since then. The fire sand is mined by stripping and open pit mining as described under Gladding, McBean and Company. It is then trucked to the railroad and hauled to Lincoln and elsewhere for use as setting sand and to a lesser extent in fire brick.

Kaolin-Frye Pit. Location: 0.5 of a mile N. 41° E. of Buena Vista on the east side of the Ione-Buena Vista road; SW$\frac{1}{4}$ sec. 8, T. 5 N., R. 10 E., M.D.M. Ownership: The north end of the property is owned by the Calaveras Cement Company, 315 Montgomery Street, San Francisco 6, and the south end is leased by the Calaveras Cement Company from Pearl T. Fye.

A very low-iron phase of the Ione sand is mined from the Ione sand bed in the upper part of the lower member of the Ione formation. Reddish brown terrace gravel and alluvium up to 18 feet thick overlie white and yellow Ione sand up to 25 feet thick. Below the Ione sand is lignite and black clay. The pit is on the east side of the Buena Vista basin where the beds have a very low dip to the west.

The pit was started in January, 1950 and has been the source of a low-iron, high-alumina, high-silica material for the manufacture of white portland cement at the Calaveras Cement Company plant at San Andreas, Calaveras County. Only the white Ione sand is usable for this purpose, and therefore the yellow Ione sand is stripped off and rejected along with the reddish brown conglomerate above. The white clayey sand is loaded into trucks with a pay-loader and hauled to the plant at San Andreas. (See Pask and Turner, 1952.)

Laterite Pit. Location: 4.0 miles N. 67° W. of Ione in lot 238 of Rancho Arroyo Seco. The Laterite pit is in the W$\frac{1}{2}$ sec. 16, T. 6 N., R. 9 E., M.D.M. (projected) just north of Jones Butte. Ownership: Charles S. Howard Estate, c/o Crocker First National Bank of San

Francisco, Post and Montgomery Streets, San Francisco, leased since 1948 to Gladding, McBean and Company, 2901 Los Feliz Boulevard, Los Angeles 26.

Deep red laterite and lateritic clay are mined where they crop out a short distance north of the Edwin clay area around Jones Butte. The laterite was formed by intense tropical weathering during the Eocene epoch from Jurassic greenstone of the Logtown Ridge formation. The industrial value of the laterite is in its relatively low silica content (25 to 30 percent SiO_2) and mining is therefore restricted to the upper, more weathered part of the laterite profile where silica has been leached out. Downward the weathering becomes progressively less pronounced until fresh rock is reached. The entire weathered section is in many places over 100 feet thick but only the upper 10 to 15 feet have the desired chemical composition. Much of the laterite mentioned in the literature on the Ione area is not residual laterite but sedimentary laterite that was reworked into the base of the Ione formation. Such material immediately underlies the Edwin clay in most localities where the base of the Edwin clay has been exposed.

The presence of laterite in the Jones Butte area has been noted by most of the geologists working in the area (Whitney, 1865, p. 289; Turner, 1894; Dietrich, 1928, p. 54; Allen, 1929; Bates, 1945, pp. 13-15). It was not until 1949, however, that a commercial use was found for this laterite. In that year the Permanente Cement Company at Permanente, Santa Clara County, started using it in portland cement. The laterite is blasted and loaded into trucks with a power shovel, and then hauled to the railroad about half a mile away where it is shipped to Permanente.

Newman Red Pit. Location: 1.1 miles S. 18° E. of Ione in part of the old Newman pit. The Newman Red pit is on the east side of the Amador Central railroad and just north of the Western Refractories Company plant; NW¼ sec. 31, T. 6 N., R. 10 E., M.D.M. Ownership: Nettie V. Gradwohl (1945). The pit is leased by Western Refractories Company, Russ Building, San Francisco.

Red and buff mottled, plastic clay called Newman Red clay is mined from the upper part of the lower member of the Ione formation. It is very similar in its appearance and physical properties to the Ione Red clay except that it contains less sand and has a P.C.E. 2 to 3 cones higher. The Newman Red clay is 18 to 20 feet thick in this pit, with a bed 1 foot to 3 feet thick of white clay at the top and 10 to 15 feet of stripping consisting of clayey sand above that.

The pit was started in 1927 and has been active continuously since then. Mining is from an open pit with a power shovel after the sandy overburden has been removed. The thin bed of white clay above the red mottled clay is mined along with the Newman Red. None of the Newman Red is used in Western Refractories Company's Ione plant but is shipped to ceramic plants elsewhere.

For references dealing with the Newman Red pit, see the tabulated list at the end of this report.

Tiger Creek Deposits. Location: SW¼ SW¼ sec. 23, T. 8 N., R. 14 E., M.D.M., 1.6 airline miles due east of Cooks Station. Ownership: Winton Lumber Company, Martell, California.

FIGURE 26. Newman Red pit showing thin bed of white clay between overburden and Newman Red clay. Camera bearing southeast. *Photo by Mort D. Turner.*

FIGURE 27. Solari pit. Upper half of face is overburden and lower half is red and buff Ione sand. Camera bearing west. *Photo by Mort D. Turner.*

This deposit of halloysitic clay, which is exposed by Tiger Creek and a tributary creek, is approximately 500 feet in diameter. The clay is brittle with low plasticity, and the color is white, pink, and brown to rust-red. Overburden consists of alluvium and soil as much as 10 feet in thickness. Iron oxide is concentrated irregularly through the clay body, while quartz and other mineral grains are present as impurities. This deposit is the result of hydrothermal alteration of andesitic sediments and agglomerates of the Miocene Mehrten formation.

There is no recorded production of clay from this property although there is a 17-foot vertical shaft.

Western Refractories Company. Western Refractories Company, Russ Building, San Francisco, operates a number of clay pits and a refractory brick plant in Amador County. The various pits are separately described.

The Western Refractories plant (Tucker, 1914, p. 11; Boalich, 1920, p. 38; Logan, 1923, p. 96; 1927, p. 141; Dietrich, 1928, pp. 60-61) is 1.4 miles S. 18° E. of Ione on the Amador Central railroad; NW$\frac{1}{4}$ sec. 31, T. 5 N., R. 10 E., M.D.M. The plant was built in 1906 by the Ione Fire Brick Company and purchased by the Western Refractories Company in 1944.

Raw materials passing through the plant follow three different flow patterns. One for stiff-mud brick, another for dry-press brick, and a third for ground fire clay. For stiff-mud bricks the various clays and grog are fed into a dry pan and ground together. After screening, the batch is mixed with water in a pug mill, passed through a de-airing machine, and extruded as a bar. The bar is wire cut and the bricks repressed. These green bricks are dried in the drying yard or pass through a dryer. After drying they are fired. Clays for dry-press bricks are separately ground in a dry pan and then mixed in a wet pan where a small amount of water is added. The mix is sent to a dry press and from there directly to the kilns for firing. Clay to be sold as ground fire clay is ground, screened, and bagged.

The plant contains six bee-hive, down-draft kilns fired by fuel oil. The kiln cycle is as follows:

setting	4 days
burning	11 days
cooling	8 days
drawing	4 days

It therefore takes 27 days from the time the loading of a kiln is started until it is ready to load for the next cycle.

Seven grades of fire bricks, with various shapes of each, are produced by the Western Refractories Company at its Ione plant.

Yosemite Pits (Harvey Pits). Location: 1.2 miles N. 16° W. of Carbondale; W$\frac{1}{2}$ sec. 29, T. 7 N., R. 9 E., M.D.M. Ownership: Western Refractories Company, Russ Building, San Francisco.

Bluish-gray fire clay is mined from the lower member of the Ione formation. There are two types, Yosemite No. 1 clay, which is in beds 8 to 9 feet thick and has a P.C.E. of cone 32 to 33, and Yosemite No. 2 clay, in beds below the No. 1, which is 6 to 10 feet thick, more sandy, and has a P.C.E. of cone 30 to 31.

Above the Yosemite clay is 5 to $5\frac{1}{2}$ feet of reddish brown gravelly soil and below is carbonaceous clay and lignite and then more clay. The clay beds gradually thin to the north.

The Yosemite clay is used primarily in refractories. It is mined in large shallow pits by power shovel and hauled by truck to the Western Refractories plant at Ione. There are three pits on the property, two of which are active.

FIGURE 28. East face of Yosemite pit showing bank of Yosemite No. 1 clay. *Photo by Mort D. Turner.*

Glass Sand

From 1903 to the middle 1920's there was intermittent production of glass sand in Amador County. All of the glass sand now produced in California is used in the manufacture of bottle ware, although some early production from Amador County went into window glass (Turner, 1950, p. 257). The sands occur interbedded with clay in the Ione formation.

Prior to and during World War I and in the early 1920's, glass sand was produced from a pit half a mile east of Ione on the Southern Pacific Railroad. It was operated by the Philadelphia Quartz Company in the early 1920's. Sand and clay were mined, broken up in heaters, and sent to classifiers, which separated the sand from the clay. The sand was then run over concentrators, which removed the heavy black sand, and the glass sand was recovered as middling. Production was 25 tons of sand per day (Hamilton, 1920, p. 39).

Custer (Grog) Pit. Location: 1.3 airline miles S. 52° E. of Ione: SE¼ sec. 30, T. 6 N., R. 10 E., M.D.M. Ownership: E. W. Custer and leased to Western Refractories Company, Russ Building, San Francisco.

Sand and gravel, with a silica (SiO_2) content of over 90 percent, is mined from a gravel bed in the lower(?) member of the Ione formation. The portion of the bed that is mined is over 20 feet thick and lies under 10 to 12 feet of overburden.

The pit that is now being worked was begun about 1944 but adjacent pits in the same bed are much older. Mining is in an open pit by means of a power shovel. The sand and gravel is trucked to the Western Refractories Company plant where it is crushed and used as a grog with refractory clay. The pit is active at the present time.

Soapstone and Talc

Small amounts of soapstone have been produced intermittently from Amador County since 1911. Although soapstone commonly contains a higher proportion of the mineral talc (basic magnesium silicate) than do some commercial "talcs," the term soapstone, as ordinarily used, implies the presence of impurities that prevent the use of the material as a high-grade commercial talc (Wright, 1950, p. 277). Most of the soapstone produced in Amador County has been utilized as a roofing filler, soapstone pencils, and for other minor industrial purposes. Soapstone deposits are most commonly associated with serpentine and talc-actinolite schist.

Light green talc crops out 6 miles northeast of Ione in sec. 4, T. 6 N., R. 10 E., M.D.M. In 1939, the Walter S. McLean Company of San Francisco did some work on a soapstone deposit east of Ione. D. E. Jones of Pine Grove producd soapstone during 1944.

MINERAL PROCESSING

Calaveras Ironstone Company. Location: NW¼ sec. 11, T. 7 N., R. 10 E., M.D.M., at the site of the old Plymouth Consolidated mine yard, and subsequently, the site of the Plymouth Rock Wool Manufacturing Company's plant in Plymouth.

In August, 1950, John Johnson, self-employed owner of the company, began to screen, clean, and bag tiny glass beads, formerly a waste product from the manufacture of rock wool, for use in sandblasting. Three sizes of 7, 20, and 30 mesh beads are bagged and shipped to the market. Production is intermittent, depending upon the market conditions, according to Mr. Johnson.

Dunlavy Concrete Block Plant. Location: ¼ mile south of Jackson on old state highway 49.

In 1946 Leo Dunlavy erected a plant for the manufacture of concrete blocks and has operated almost continuously since that date. Pumice, shipped by railroad from Bend, Oregon, sand from Lancha Plana, and Portland cement supplied by the Pacific Portland Cement Company are the principal constituents used.

By volume, two-thirds pumice and one-third sand are mixed to form an aggregate. One part cement is then added to $8\frac{3}{8}$ parts aggregate, $6\frac{1}{2}$ gallons of water are added per cubic foot of cement used. Three ounces of D-4 granular soap are added to increase the plasticity of the mixture and a small amount of coloring matter is also added. This material is mixed in an electrically operated pugmixer having a capacity of 9 cubic feet. Mr. Dunlavy reports that the raw material is mixed for 15

FIGURE 29. Dunlavy concrete block plant, Jackson. Concrete blocks are drying in right background.

minutes in the pubmixer which rotates at a rate of 26 revolutions per minute.

The mixture is then delivered by a 21-foot rubber conveyor belt into a hopper. From the hopper it is introduced by gravity into two block molds mounted on an electrically operated vibrator. Each mold shapes four concrete blocks at one time. The vibrator causes the plastic mixture to fill the mold completely. The wet blocks are then pressed out of the molds by a press, operated by hand lever, onto wooden pallets.

The pallets, each with four blocks, are wheeled into a yard where the blocks are stacked for drying. Complete drying of the blocks requires at least 28 days. The blocks range from light gray to light pink in color. The most popular size is 8-by-4-by-16 inches.

Concrete blocks are used chiefly in the construction of private homes although they find some use in the construction of small public and farm buildings.

Concrete blocks are sold on a contract basis to the consumer so that enough blocks are produced at one time to build a complete structure. An average five-room house requires between 1400 and 1800 8-by-4-by-16 inch blocks. Two or three men including Mr. Dunlavy operate the plant.

Orr Custom Mill. Location: NW¼ sec. 10, T. 7 N., R. 10 E., M.D.M., 1¼ miles west of Plymouth just south of the Plymouth-Latrobe road. Ownership: Orr, Ellwood, Plymouth, California.

Early in 1936 Ellwood Orr of Plymouth erected a mill which catered to small gold operators. The mill was in operation until the middle of 1937, according to Mr. Orr. Since that date it has been idle.

Ore was delivered by truck and dumped into a bin. From there it went through a 10-stamp mill, amalgamation tables, a Wilfley table, and Frue vanners. A small ball mill was used for regrinding. Capacity was 50 tons per day. When in operation six men were employed.

Plymouth Rock Wool Company. Location: Near the center of sec. 11, T. 7 N., R. 10 E., M.D.M., on Plymouth Consolidated mine property. W. H. Danzer of North Sacramento leased the property from the Argonaut Mining Company, owners of the property at that time. The manufacture of rock wool for insulating purposes began in 1944 and continued almost steadily until the fall of 1950, according to Lawrence Burke. The plant has since burned down.

Copper slag from the Copper Hill mine was mixed with coke and melted in a brick-lined furnace. Pressurized steam was blown through the molten mass to form a fluffy rock wool. The finished product was bagged and shipped to market. On construction jobs requiring insulation, a portable blower was mounted on a truck and rock wool was delivered into the area to be insulated.

Plant capacity ranged from 4000 to 8000 pounds of rock wool per day. During the years of operation the plant utilized 8000 to 10,000 tons of slag per year, according to Mr. Burke.

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TABULATED LIST OF MINES AND PROSPECTS IN AMADOR COUNTY

The following list of mines and prospects in Amador County is arranged alphabetically by commodity and by name of prospect or mine. Numbers which appear in the left-hand column under the heading *Map No.* refer to the *Geologic Map of Amador County Showing Mines and Mineral Deposits,* Plate 1.

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CHROMITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
1	Allen property (Johnson lease)	George Allen, Sutter Creek	27, 28	6N	10E	MD	Two shafts, 10 feet apart, 12 and 30 feet deep and shallow cut. An 18 to 20 inch chromite lens exposed bottom of 12-foot shaft worked out? (Cater 48:55)
2	Carr and Mefford (Mooney claim)	Frank and Rose Devencenzi, Volcano	$W\frac{1}{2}$ $SE\frac{1}{4}$ 34	6N	10E	MD	Chromite mined from open cuts and some underground workings which are now largely caved. Last worked 1918. (Bradley et al. 18:116; Cater 48:53)
	Courtwright property (Daggett lease)	Carl H. Kremmel, R.F.D. Ione	$SE\frac{1}{4}$ 3	5N	10E	MD	Chromite mined by adits, raises, and shafts which are flooded and inaccessible. Last worked 1916. (Bradley et al. 18:117; Cater 48:53)
	Courtwright property (Woods and Roach lease)	Emma Garibaldi, Jackson	$NE\frac{1}{4}$ $SW\frac{1}{4}$ 34	6N	10E	MD	Chromite mined from two shafts, 30 and 32 feet deep. Ore occurs as small lenses in a schistose serpentine (Cater 48:54)
	Detert property	W.F. Detert Estate 1715 Mills Tower, San Francisco	near center 6	7N	10E	MD	Workings all shallow. Much of chromite ore was plowed from soil overlying serpentine. Last worked World War I. (Bradley et al. 18:117; Cater 48:55-56)
3	Ellis property	J.M. Ellis, Box 98 Jackson	$NW\frac{1}{4}$ $SW\frac{1}{4}$ 2	5N	10E	MD	Workings consist of one small pit and a number of prospect trenches. Lenses of chromite in serpentine are small, ranging from 1 to 3 feet thick and up to 25 feet long. Last worked World War I. (Cater 48:53)
	Fields	Adrian Fredricks, Ione	$SW\frac{1}{4}$ 10	5N	10E	MD	Chromite mined from inclined shaft. The ore occurs as lenses with some uvarovite. Last worked 1918. (Cater 48: 52)
	Kremmel and Froelich	Fred W. DuFrene et al. Ione	$NW\frac{1}{4}$ $NE\frac{1}{4}$ 34	6N	10E	MD	Chromite mined from small open cut and adit with stoping to surface. Small stringers of disseminated and massive ore in serpentine. Last worked 1916. (Cater 48:54)

CHROMITE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Taylor Ranch	W.F. Detert Estate 1715 Mills Tower, San Francisco	NE$\frac{1}{4}$ 6	7N	10E	MD	Chromite mined from shallow pits. Irregular lenses of ore in highly sheared serpentine (Cater 48:56)
	Wait property	A.L. and R.A. Wait Plymouth	NW$\frac{1}{4}$ 29	7N	10E	MD	Several small pods and lenses chromite mined from open cuts. Last worked 1916. (Bradley et al. 18:117; Cater 48:55)

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Allen: See Hayward						
	Bull Run	East Bay Municipal Utility District Oakland	15	5N	10E	MD	Shipped during sixties; 400-foot shaft. (Aubury 05:186; 08:225; Logan 27:149; Jenkins 48:214)
	Chaparral	East Bay Municipal Utility District Oakland	10	5N	10E	MD	Opened 1864; 120-foot shaft (Aubury 05:186; 08:225; Jenkins 48:214)
4	Copper Hill	W.F. Detert Estate, 1715 Mills Tower, San Francisco	34 35	8N	9E	MD	(Aubury 05:186-187; 08:226-227; Logan 27:148; Raymond 74:87; Tucker 14:12-13; Jenkins 48:214; herein)
	Forest Home	Annie L. Devore, Plymouth	9	7N	9E	MD	Four shafts 80 feet deep. (Aubury 05:187; 08:227; Jenkins 48:215)
	Hayward (Allen)	Allen Estate Co., Sutter Creek	28	8N	10E	MD	Chalcopyrite associated with pyrite and some sphalerite (Tucker 14:12; Jenkins 48:215, pl. 13)
	Ione City	Pearl T. Fye, Ione	3,4	5N	10E	MD	Operated in sixties (Aubury 05:186; 08:225; Jenkins 48:215)
	Ione Copper (Irish Hill)	Crocker First Nat'l. Bank, San Francisco	2	6N (Arroyo	9E Seco)	MD proj.	In greenstone just east of slate belt. Reported to have produced some stibnite as well as copper ores. On Arroyo Seco grant. (Aubury 08:227; Lang 07:909, 964, 966; Logan 27:149; Tucker 14:13; Jenkins 48:215)
	Irish Hill: See Ione Copper						
	Johnson Ranch	Frank Boscovich, Jackson	25,35 36	6N	10E	MD	Shafts 90, 60 feet deep; vein up to 12 feet. (Aubury 08:227; Tucker 14:13; Jenkins 48:215)

COPPER, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Moon	Lorraine McCarthy Davis, 747 La Paloma Road, Richmond	3, 9, 10	5N	10E	MD	Shafts 140 and 100 feet deep. (Aubury 05:185-186; 08:224-225; Tucker 14:13; Jenkins 48:216)
5	Newton	Fred W. DuFrene et al, Ione	28	6N	10E	MD	(Aubury 05:183-185; 08:222-224; Browne 67:143, 149, 166-167; Irelan 88:106-108; Logan 27:148; Raymond 74:47-87; Tucker 14:13; Jenkins 48:216, 49-60, pl. 7-11; herein)
	Russel	Adrian Fredricks, Ione	10	5N	10E	MD	Large dump; 200-foot shaft (Aubury 05:186; 08:225; Jenkins 48:216)
	Thayer (Grayhouse, Grey House)	East Bay Municipal Utility District, Oakland	23	5N	10E	MD	Shaft 240 feet deep; drilled by U.S. Bureau of Mines, 1943. (Aubury 05:186; 08:225; Tucker 14:14; Jenkins 48:85-91, 216, pl. 33)

GOLD, LODE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	A and B	Reaves, M.H. & L.D. c/o L.D. Reaves, 1704 N St., Sacramento 14	11,14	7N	10E	MD	Inclined shaft 175-ft. deep, two crosscut adits, and 200-ft. open cut. (Tucker 14:14; Logan 27:186; Logan 35:80)
	Acme: See Fort Ann						(Crawford 96:66, Tucker 14:14; Logan 27:186)
	Acme Cons. et al.	E.J. and J.M. Muldoon 206 Auburn St., Modesto	9	5N	11E	MD	(Logán 27:186)
	Aetna: See Amador Gold						
6	Alma	Ralph McGee, Sutter Creek	29	6N	11E	MD	Main shaft is 1000 ft. deep. Some work done in 1948 in smaller 115-ft. deep shaft. (Crawford 94:70; Crawford 96:66-67; Tucker 14:14-15; Logan 27:186)
	Alphi	Lauren E. Wilkenson 617 W. Pine St., Lodi	34,35	6N	11E	MD	(Logan 34:117)
	Alta	L.F. and Lillie Payton, Pine Grove	28	7N	12E	MD	
	Alta extension	L.F. and Lillie Payton, Pine Grove	28	7N	12E	MD	
7	Amador Gold	Ralph McGee, Sutter Creek	34	6N	11E	MD	Most work done before 1900. Mine has 800-ft. inclined shaft and five levels (Irelan 88:88-81; Crawford 94:71; 96:72; Tucker 14:15; Storms 00:44; Logan 27:186; Logan 34:60,117)
	Amador Queen #1: See Amador Gold	Ralph McGee, Sutter Creek	34,35	6N	11E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
8	Amador Queen #2	Ralph McGee, Sutter Creek	34,35	6N	11E	MD	(Irelan 88:91,93; Irelan 90:107; Crawford 94:71; Storms 00:44; Tucker 14:16; Logan 27:186; Knopf 29:70; Logan 34:60,61,117; herein)
9	Amador Star	Kaiser, Eliza M., 720 West Poplar St., Stockton	23	8N	10E	MD	(Logan 27:186; Logan 34:61-62; Jenkins 48:65-66; herein)
	Anita	O'Grady, Geo. E., Jackson	28	6N	11E	MD	750-ft. inclined shaft (Crawford 96:68; Tucker 14:16; Logan 27:186; Logan 34:117)
10	Argonaut	B. Monte Verda and E.C. Taylor, 369 Pine St., San Francisco	17,20 21	6N	11E	MD	(Crawford 96:68; Tucker 14:17-19; Logan 21:406-408; 22:23-24; 23:13-14; 24a:2; 24c:177; 27:153-157,186; 34:62-70,117; Storms 00:50-52; Knopf 29:66-68; Jenkins 48:64; herein)
	Atlantic	Detert, W.F. Est., 1715 Mills Tower Building San Francisco	13,14	7N	10E	MD	(Logan 34:117)
11	Ballard	Ballard Mother Lode Mines, Ltd. c/o John Ratto, Sutter Creek	14 23	8N	10E	MD	(Logan 34:70,117; herein)
	Baratini	East Bay Municipal Utility District, Oakland	15	5N	11E	MD	
	Battle Mountain	William Logomarsino et al, Volcano	22	7N	12E	MD	
12	Bay State	California Lands Inc. c/o Capital Co., #1 Powell St., San Francisco	23	8N	10E	MD	Opened in early 1890's. Main shaft is 1065 ft. inclined with 7 levels. Last production was 1909. Reopened in 1933 but nothing produced. Shaft dewatered in late 1934. Work done on 300 level in early 1935. (Irelan 93:146; Crawford

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
12	Bay State (cont'd)						94:71; 96:69; Tucker 14:19-20; Storms 00:85-86; Logan 27: 187; 34:71,117; Jenkins 48:65-66)
13	Belden	Belden Amador Mines Inc., P.O. Box 28, Fort Wayne, Indiana	26	7N	13E	MD	Herein
	Bellwether	Mark Eudey, Martell	21	6N	11E	MD	Mine development began 1895. Several shallow shafts in addition to a 180-ft. and a 320-ft. shaft. (Irelan 90: 104-105; Irelan 93:141; Crawford 94:71; 96:69; Logan 27: 187; 34:71-72, 117)
	Belmont	Fred Suelberger c/o Esther J. Fitzgerald 252 Los Flores, Bakersfield	32	7N	13E	MD	Gold-quartz vein strikes north, dips 80° W in granodiorite. Some work done on 100-ft. level off main 145-ft. shaft and another shaft was sunk during 1929. (Tucker 14: 20)
	Black Hills: See Italian						
	Black Metal: See Valparaiso						
14	Black Prince	W.R. Schwickerth and P.M. Wedell, c/o W.R. Schwickerth, Pine Grove	27	7N	13E	MD	Herein
15	Black Wonder	George B. and Florence J. Taves, Pine Grove	5	6N	12E	MD	Herein
	Boro	Mary Gilbert, 2317 24th Ave., San Francisco 16	24	7N	10E	MD	(Logan 34:117)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bona Fortuna	Glen and Everett Fancher, Jackson	25	7N	10E	MD	(Logan 34:117)
	Bright: See Anita						
	Brown: See Jose Gulch						
	Bruce	Bruce Cornwall, 57 Sutter St., San Francisco	14	7N	10E	MD	(Logan 34:117)
16	Bunker Hill	Bunker Hill Mining Co. c/o C.E. Crandall North Bend, Washington	25 36	7N	10E	MD	(Irelan 88:57-63; 90:75,114; 93:79; Crawford 94:79; 96:77; Storms 00:80; Tucker 14:20-21; Logan 21:408-409; 22:24; 23:298-299; 23:2,15; 24a:2; 27:157-158,187; 34:72-74; Knopf 29:55-56; Jenkins 48:65; herein.)
	California	W.T. Kneen, Box 351, Mooreland, Oklahoma	20	7N	13E	MD	See Lone Willow group.
	California group	W.F. Detert Estate 1715 Mills Tower, San Francisco	24	7N	10E	MD	First worked in 1852. Some work done during middle 1930's. (Logan 27:187; 34:81.)
	Caucasian Consolidated	Ralph McGee, Jackson	23	8N	10E	MD	Along 600 ft. of contact between greenstone and slate. quartz crops out on the surface for short distances. Three shafts 104,85, and 85 ft. deep and a 500-ft. adit are located on this property (Irelan 90:120; Logan 27:188; 34:118.)
17	Central Eureka (including Old Eureka)	Central Eureka Mining Co., Russ Bldg., San Francisco	7,8	6N	11E	MD	(Irelan 88:49; 90:104,72,102,113; 93:144; Crawford 94:79; 96:67,69-70; Hamilton 14:24,28; Logan 21:409-410,411; 22:24; 23:299; 23:215,73; 24a:2,3; 24b:74; 27:158-164,176-178,188,194; 34:74-80,101,104,118,121; Storms 00:64-65;

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
17	Central Eureka (including Old Eureka) (continued)						Jenkins 48:64; herein.)
	Chief	J.J. Young, 32 Bellevue Ave., Piedmont	14	7N	10E		(Logan 27:188.)
	Chili Jim	2/5 Bruce Cornwall 57 Sutter St., San Francisco, 3/5 W.F. Detert Est., 1715 Mills Tower, San Francisco	24	7	10		(Logan 27:188; 34:118.)
	Clyde	Mark Eudey, Martell	17 20	6N	11E	MD	Part of Kennedy mine (Irelan 90:110-111; Logan 27:188; 34:118.)
	Comet	Baumhardt, Mary M. et al c/o Helen Agen, Rt. 5, Box 2060, Modesto	6	6N	11E	MD	Shaft is 200 ft. deep. (Irelan 90:114; Tucker 14:26; Logan 27:188; 34:118.)
18	Contini	Bert Contini, Jackson	9	6N	12E	MD	Herein.
	Cons. McNamara	George Newman, 2047 33rd Ave., San Francisco	3	5N	11E	MD	(Logan 27:188; 34:118.)
	Cosmopolitan	W.F. Detert Est., 1715 Mills Tower, San Francisco	14	7N	10E	MD	Worked between 1850 and 1890. Shaft was sunk 750 ft. with 6 levels (Logan 27:188; 34:118.)
	Coulter	Hobart Estate Co., and Emma Rose, 202 Hobart Bldg., San Francisco	14	7N	10E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Creek Ledge	Tony Levaggi, et al., Plymouth	35	8N	10E	MD	Mined through a 100-ft. inclined shaft. (Tucker 14:27; Logan 27:188; 34:80,118.)
	Croesus and St. Martin	Levaggi, Elvira, c/o James B. Levaggi, 2752 Buchanan St., San Francisco	26	8N	10E	MD	(Logan 34:118.)
19	Crown Point	John M. and Emma Fontenrose, Jackson	22 23	7N	10E	MD	Deepest work done is at Bonanza shaft which is 485 ft. (Irelan 90:116; Logan 27:118.)
20	Defender	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	29	7N	13E	MD	(Tucker 14:27; Hamilton 22:24; Logan 24b:75; herein.)
	Defiance	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	29	7N	13E	MD	
	Dewitt	Ralph McGee, Sutter Creek	3	5N	11E	MD	Some work done in 1933. (Logan 34:118.)
	Douglas	C.M. Farnsworth, Carrie Mason	28	7N	12E	MD	
	Dowling		27 28	6N	11E	MD	(Logan 34:118.)
	Downs	Peter Barone, Volcano	13	7N	12E	MD	Originally located in 1877. (Irelan 87:20; Crawford 94:72; 96:70; Tucker 14:27; Logan 27:189.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Doyle	Ralph McGee, Sutter Creek	34	6N	11E	MD	Shaft 150 ft. deep. (Irelan 90:107; Crawford 94:72; 96:70; Tucker 14:27; Logan 27:189; Logan 34:118.)
	Dry Creek						See Cosmopolitan.
	Drytown Consolidated						See Crown Point.
	East Amador	J.W. Bullock, c/o C.E. Crandall, North Bend, Washington	36	7N	10E	MD	
	Ebelbrau	R.L., Thelma L. Wolfe Fiddletown	23	8N	11E	MD	(Logan 27:189.)
	Eclipse						Part of Original Amador.
	El Dorado	T.C. Mayon et al, c/o Mrs. R.W. Emerson, Box 85, Centerville, Calif.	36, 31	7N 7N	10E 11E	MD MD	Shaft 300 ft. deep. (Irelan 90:99; Tucker 14:27; Logan 27:189; 34:82,118.)
	Elephantine	Daisy Thomas, Jackson	10	5N	11E	MD	(Logan 27:189.)
21	Elkhorn	Mary and Sadie R. Grillo, Volcano	32	7N	13E	MD	Herein.
	Empire	Ralph McGee, Sutter Creek	3	5N	11E	MD	(Logan 35:118.)
	Eureka	Pacific Gas & Electric Co., San Francisco	27 28	7N	13E	MD	See Old Eureka under Central Eureka. (Irelan 90:72; Crawford 96:67; Tucker 14:28; Logan 27:189; 35:118.)
	Eureka #2	W.F. Detert estate 1715 Mills Tower, San Francisco	23	7N	10E	MD	(Logan 34:119.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Excelsior	Gertrude Clark, Sutter Creek	23	8N	10E	MD	(Logan 27:189; 34:119.)
	Excelsior	J.W. Bullock, c/o C.E. Crandall, North Bend Washington	30	7N	11E	MD	Shaft is 50 feet deep (Tucker 14:28; Logan 27:189; 34: 119.)
	Farrell	Joe Rosenberg, c/o Harvey N. Seligman, 1805 Sharp Ave., Walnut Creek	15	5N	11E	MD	Some activity in 1937. (Irelan 90:107-108; Crawford 94: 72; 96:70; Tucker 14:28; Logan 27:189; 34:119.)
	Florence	Kenneth W. Dennison 636 33rd Ave., San Francisco 21	4	6N	12E	MD	(Logan 27:189.)
22	Fort Ann	William L. Metcalf Box 32, Volcano	W½ 2	7N	12E	MD	Formerly known as Acme and Robinson. (Crawford 96:66; Tucker 14:14; Logan 27:186; herein.)
	Fort John	Emma Rose, c/o E.C. McCurdy, Mills Bldg. 220 Montgomery St., San Francisco	11	7N	10E	MD	(Logan 27:189; 34:119.)
	Forty-nine	E.S. Barney Est., c/o Anna M. Irving, 1505 Hillcrest Ave., Orlando, Florida	14	7N	10E	MD	(Irelan 90:122; Logan 27:189; 34:119.)
23	Fremont-Gover	Fremont Gover Co., c/o C.B. Braun, Sec'y., Rt. 3, Box 306, Albany Oregon	25	7N	10E	MD	(Irelan 88:53-57; 90:75; 93:146; Crawford 94:72-74; 96:71 Storms 00:80-81; Tucker 14:28-29; Logan 21:411; 22:24; 23:299; 23:15,73,143; 24a:2; 27:165-166,190; Knopf 29:52-54; Logan 34:82-84,119; Jenkins 48:65; herein.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Goat Ranch	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	8N	10E	MD	
	Golden Crown	Wendell A. Boitano Sutter Creek	18,19	7N	11E	MD	(Logan 27:190.)
	Golden Eagle	Helen Crotty, Sutter Creek	6	6N	11E	MD	(Irelan 90:113-114; Logan 27:190; 34:119.)
	Golden Gate	John F. Davis Estate 2872 Jackson St., San Francisco	14	7N	10E	MD	(Logan 27:190; 34:119.)
	Golden Gate	W.F. Detert Estate 1715 Mills Tower, 220 Bush St., San Francisco and Geo. Kretcher Jr. Plymouth	14	8N	10E	MD	(Logan 27:190; 34:119.)
	Golden Gate	Chas. W. Cassinelli c/o A. Marre, 643 Chetwood St., Oakland	12 13	7N	12E	MD	
24	Gold Mountain	Gold Mountain Mining Co., c/o Wm. D. Shea Jr., 1249 Russ Bldg. San Francisco	19	7N	11E	MD	Active in 1890's, shaft sunk in 1935, some prospecting done in 1945. Extensive quartz outcroppings, free gold with pyrite and small amounts arsenopyrite and galena. Silver content high. Adit and 100-ft. shaft. (Irelan 88: 94; 93:145; Crawford 94:72; 96:71; Logan 27:190.)
	Gover						See Fremont.
	Governor Bradford	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Great Eastern	J.W. Bullock, c/o C.E. Crandall, North Bend Washington	36	7N	10E	MD	
	Great Eastern	Great Eastern Mining Co., c/o Elmer Tripp Plymouth	23	8N	10E	MD	(Logan 27:190; 34:119.)
	Green	J.J. Young, 32 Bellevue, Piedmont	14	7N	10E	MD	
	Grey Eagle	O. Ball, c/o Laura C. Bell, Plymouth	2	7N	10E	MD	
25	Hageman	Frank E. Cotie and Vernie Hoffschneider	N½33	7N	13E	MD	(Logan 23:7; 27:190; herein.)
26	Hardenburg	Ralph McGee, Sutter Creek	10 3	5N 6N	11E 11E	MD MD	Vertical shaft 1500 ft. deep. Last worked in 1918 (Irelan 90:68,106-107; 93:139-140; Crawford 94:74; 96:71; Tucker 14:29-30; Logan 27:166,190; 34:84-85,119.)
	Haywire						See Elkhorn.
	Hazard						See Treasure.
	Henry Clay						See Cosmopolitan.
	Hercules	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	(Logan 27:191; 34:119.)
	Homestake	Alex C. and Mae M. Matulich, Drytown	14	7N	10E	MD	
	Honula	West Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave.	32	7N	13E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Honula (cont'd)	New York, New York					
	Illinois, Green, et al.	J.J. Young, 32 Bellevue Ave., Piedmont	35	8N	10F	MD	(Irelan 90:119; Logan 27:191; 34:119.)
	Indiana	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	11	7N	10E	MD	Part of Plymouth Consolidated.
	Isaac Newton	James C. Harle, c/o Milbank, Tweed, Hope et al., 15 Broad St. New York, New York	31	6N	11E	MD	Adit 300 ft. long (Tucker 14:30; Logan 27:191.)
27	Italian	Black Hills Mining Co. c/o Wm. Tam, Jackson	24	7N	10E	MD	(Irelan 90:115-116, Logan 27:191; 34:85,119; Jenkins 48:65; herein.)
	Jack	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	32	7N	13E	MD	
	Jackson	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	20	6N	11E	MD	(Logan 35:119.)
	Jill	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	32	7N	13E	MD	
	Joe Davis	W.F. Detert Estate	13,14	7N	10E	MD	(Logan 34:119.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Joe Davis (cont'd)	1715 Mills Tower, San Francisco					
	Jose Gulch (Brown Aurora et al.)	Joseph A. Lema, Jackson	2 35	5N 6N	11E 11E	MD MD	200-ft. shaft. (Tucker 14:30; Logan 27:191; 34:117.)
	Julia	M.C. Quinn, c/o Mrs. E. Sargent, Jackson	10	5N	11E	MD	
28	Jumbo	Behrend Doscher, Pioneer Station	SW$\frac{1}{4}$ 26	7N	13E	MD	Herein.
	Jupiter	M.F. Gates, c/o Alex R. Smith, 700 San Antonio Way, Sacramento, and Alex R. Smith	21 22	8N	11E	MD	(Logan 27:191.)
	Kelly	Hoit C. Vicini and Margaret V. Hobbs, 48 Maple Ave., Atherton	3	5N	11E	MD	Shaft 90 ft. deep. (Irelan 90:108; Crawford 94:74; 96:72; Tucker 14:30; Logan 27:191; 35:120.)
29	Kennedy	Mark and Frances Eudey, Martell	16,17 20,21	6N	11E	MD	(Irelan 88:66-71; 90:103-104; 93:141-142; Crawford 94:77; 96:72; Storms 00:52,60; Tucker 14:31-34; Logan 21:408; 23:299; 23:15; Root 24a:2-3,177; 27:166-169,191; Knopf 29:63-66; Logan 34:85-91,120; Jenkins 48:62,64; herein.)
	Kennedy Extension	Mark and Frances Eudey, Martell	20	6 N	11 E	MD	(Logan 27:191.)
30	Keystone	Keystone Mining Co. c/o John D. Culbert Amador City	36	7N	10E	MD	(Hanks 86: pt. II, 16-17; Irelan 88:63-66; 90:72-73,98; 93:145; Crawford 94:77; 96:72; Storms 00:77-80; Tucker 14: 34-36; Logan 21:411; 27:169-170; Knopf 29:58-59; Logan 34: 91-95; Jenkins 48:65; herein.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Kruger & Vaughn	W.W. Steele, Jackson 1/10 int., Geo. M. Thomas, Jackson, 9/10 interest	3	5N	11E	MD	Greenstone hanging wall, slate footwall. (Irelan 90:107; Logan 27:192; 34:95.)
	Last Chance	J.W. Bullock, c/o C.E. Crandall, North Bend Washington	36	7N	10E	MD	240-ft. shaft, wholly in slates. (Irelan 90:115; Logan 27:192; 34:120.)
31	Lincoln						See Lincoln Consolidated.
	Lincoln Consolidated	Lincoln Gold Mining Co., 807 Lonsdale Bldg. Duluth, Minnesota	6,7 8	6N	11E	MD	(Irelan 88:73,75-79; 90:100,101-102; 93:144; Crawford 94:79-80; 96:73-74,78-79; Storms 00:65-75; Tucker 14:36-37; Logan 27:170-172; 34:95-97; Jenkins 48:64; herein.)
	Little Amador						See Original Amador.
	Littlefield	Ralph McGee, Sutter Creek	10,15	5N	11E	MD	Active in 1893. (Crawford 94:78; 96:74-75; Tucker 14:39; Logan 27:193; 34:121.)
	Little Sargent	Anthony B. Caminetti Jackson	10	5N	11E	MD	(Logan 27:192; 34:120.)
	Lone Willow Group	Joe Porter, Jackson	20	7N	13E	MD	350-ft. tunnel, 100-ft. shaft, tunnel cleaned out and extended in 1935. (Tucker 14:37; Logan 27:192.)
	Lucky Girl	Joseph G. and Mary Dunleavy, Box 28, Pioneer Station	29	7N	13E	MD	
	Lucky Strike, et al.						See Pioneer Lucky Strike.
	Madrona Group						See Pioneer Lucky Strike.
32	Mahoney						See Lincoln Consolidated.

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mammoth	East Bay Municipal Utility District, Oakland	10	5N	11E	MD	
	Mammoth	Mammoth Mining Co., c/o Anna M. Kerby, Elk Grove	3	6N	12E	MD	
33	Marklee	Marklee Mining Co. c/o T.C. Malloy, 1036 Main St., Napa	1	7N	12E	MD	Idle since 1926. 500-ft. shaft, 800-ft. drift, 1500 feet underground workings. Northwest ore shoot. (Crawford 96:74; Tucker 14:38; Logan 24a: 3; 24b:73-74; 27:172-173.)
	Marlette	Mrs. J.E. Sargent, Jackson	10	5N	11E	MD	See Sargent.
	Maryland	Bruce Cornwall, 57 Sutter St., San Francisco	24	7N	10E	MD	(Logan 34:120.)
	Mayella	W.A. Wilds et al., c/o Mayella Casinelli, Ione	11	7N	10E	MD	(Logan 27:193; 34:120.)
	Mayflower						See Bunker Hill.
	McIntire	J.A. McIntire, c/o H.S. McIntire, 2723 U St. Sacramento	6	6N	11E	MD	210-ft. inclined shaft, 80-ft. shaft, slate hanging wall, greenstone footwall, active in 1895. (Irelan 90:115; Crawford 96:74; Tucker 14:38; Logan 27:193; 34:120.)
	McKay and Love	Hoit C. Vicini and Margaret V. Hubbs, 48 Maple Ave., Atherton	3	5N	11E	MD	See Amador Gold.
	McKinney and Crannis	Mrs. Elsie A. McKinney 506 Park Blvd., Ukiah	10 15	5N	11E	MD	5-ft. vein on slate-greenstone contact, abundant arsenopyrite, 200-ft. adit reopened in 1934. (Irelan 90:106; Logan 27:193; 34:118.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mechanics	G. Allen Jr., Sutter Creek	4,5 32,33	6N 7N	11E 11E	MD MD	Active in 1895. North-trending vein with greenstone hanging wall and slate footwall, 240-ft. incline shaft with 100 and 200 levels. (Irelan 90:112; Crawford 96:74; Storms 00:76; Tucker 14:38; Logan 27:193; 34:120.)
	Middle Bar Q.M.	East Bay Municipal Utility District, Oakland	10	5N	11E	MD	See Littlefield.
	Middle Bar Group	East Bay Municipal Utility District, Oakland	3,10 15	5N	11E	MD	See Littlefield.
	Mikado						See Contini.
	Mineral Point	Domenico Boro, c/o Gene Boro, Jackson	3	5N	11E	MD	(Logan 27:193; 34:121.)
	Modoc	B.H. and Stella M. Mace, Pine Grove	21	7N	13E	MD	Active in 1895. (Crawford 96:74; Tucker 14:38; Logan 27:193.)
	Monitor	Tony Levaggi et al. Plymouth, $\frac{1}{4}$, Chas. H. Shields et al., 580 Polk St., Apt. 2, Monterey, $\frac{1}{2}$, D.J. Wilds et al. c/o Mayella Casinelli, Ione, $\frac{1}{4}$	13 14	7N	10E	MD	(Logan 27:193; 34:121.)
	Monte Richard	Ambrose and Guido Garbarini, c/o Babe Garbarini, Jackson	21 30	7N 6N	13E 11E	MD MD	
	Monte de Oro	Tony Levaggi, et al. Plymouth	26 35	8N	10E	MD	Massive quartz outcrops, 500-ft. open cut, 785-ft. tunnel, some activity in 1934. (Tucker 14:38; Logan 27:193; 34:

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Monte de Oro (cont'd)						121.)
34	Moore	South Jackson Mining Co., c/o J.Schweitzer Jackson	34 33	6N	11E	MD	(Hanks 26:pt. II, 20; Irelan 88:84-85; Crawford 94:78; 96:74; Tucker 14:38; Logan 22:24; 23:299-300; 23:15-16; 24a:3; 24b:74; 24c:177; 27:173-175; Knopf 29:68-69; Logan 34:98-99; herein.)
	Mountain King, Mountain Queen	William B. Pitts, Pine Grove	4	6N	12E	MD	Series of north striking veins, auriferous galena present, 265-ft. shaft, 125-ft. shaft, drifts, and an adit. Active in early 1920's. A little activity in 1936. (Tucker 14:38-39; Logan 24b:74-75; 27:193.)
	Muldoon Group	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	20	6N	11E	MD	(Logan 34:121.)
	Mungo Park	W.T. Kneen, Box 351 Mooreland, Oklahoma	20	7N	13E	MD	See Lone Willow Group.
	Nevada						See Bunker Hill.
35	Nevada Wabash	Nevada Wabash Mining Co., Box 504, Sutter Creek					(Logan 27:197; 34:123; herein.)
	New Albany Consolidated						See Littlefield.
36	New Hope	Harold and Emma M. Swingle, Plymouth	3	7N	10E	MD	(Irelan 90:121; Logan 27:194; herein.)
	New London	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	
	New London	B. Monte Verda and E.C.	14	7N	10E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	New London (cont'd)	Taylor, 369 Pine St. San Francisco	11	7N	10E	MD	Now part of Plymouth Consolidated.
37	Newman	Pacific Gas and Electric Company, San Francisco	NE¼ 33	7N	13E	MD	(Logan 27:175; herein.)
	North California	W.F. Detert Estate 1715 Mills Tower, San Francisco	23	7N	10E	MD	(Logan 34:121.)
	North Eureka #2	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	(Logan 34:121.)
	North Gover (part of Fremont)		25	7N	10E	MD	(Irelan 90:116-117; Crawford 96:75; Logan 27:194; 34:121.)
	North Henry Clay	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	(Logan 34:121.)
	North Star	Nevada Wabash Mining Co., Box 504, Sutter Creek	6	6N	11E	MD	(Irelan 88:71-72; 90:99; Crawford 94:78; 96:75; Tucker 14:39; Logan 27:175-176; 34:99-101.)
	No. 1 and No. 2	Josephine Poundstone, Grimes, Colusa Co.	5,8	6N	11E	MD	(Logan 27:194; 34:121.)
38	Old Eureka						See Central Eureka.
	Old Oaker	P.A. and B.J. Southerland, 22 Linden Ave. Atherton	4	7N	10E	MD	(Logan 27:194; 34:121.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Old Lone Willow	W.T. Kneen, Box 351 Mooreland, Oklahoma	20	7N	13E	MD	See Lone Willow Group.
	Oleta	C.D. Crane, et al., Fiddletown	34 17	8N 6N	11E 11E	MD MD	300-ft. shaft, some activity in middle 1920's. (Root 24:3; Logan 27:194.)
39	Oneida	South Eureka Mining Co. c/o A.J. Mayman, 400 California St., San Francisco	17	6N	11E	MD	(Irelan 88:79; 90:109-110; Crawford 94:78; 96:75; Storms 00:60-63; Tucker 14:39; Logan 27:194; 34:121; Jenkins 48:64; herein.)
40	Original Amador	J.W. Bullock, c/o C.E. Crandall, North Bend Washington	36	7N	10E	MD	(Irelan 88:42; 90:114; Crawford 94:78; Tucker 14:39-40; Logan 24a:3; 27:178-179; Knopf 29:56-58; Logan 34;104-105; Jenkins 48:65; herein.)
	Oro Grande et al.	Marie R. North, 2008 Birch St., San Carlos	29 32 33	7N	13E	MD	(Logan 27:194.)
	Parker	Mrs. Elsie C. Downs Sutter Creek	14	7N	12E	MD	Several adits and a shaft, some activity in 1920's. (Logan 27:194.)
	Peerless (Seaton)	Hobart Estate Co. and Emma Rose, 202 Hobart Bldg., San Francisco	24	7N	10E	MD	Vein on slate-metavolcanic contact, inclined shaft. Active around 1900. (Storms 00:45; Logan 27:194.)
41	Peterson	W.F. Peterson, Pine Grove	5	6N	12E	MD	Herein.
	Pick and Drill	Bow Bridge Development Co., c/o E. Putman Box 1069, Greenwich Connecticut	32	7N	13E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
42	Pine Grove	Wendell M. Miller and E.A. DeRuchia, Reno Nevada	23	7N	13E	MD	Herein.
43	Pine Grove unit	W.F. Peterson, Pine Grove	32	7N	12E	MD	Herein.
	Pioneer	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	25	6N	11E	MD	See Argonaut.
	Pioneer	Glen and Everett Fancher, Jackson	14	7N	10E	MD	Two veins in Mariposa slates, 550-ft. inclined shaft, 5 levels, produced up to $15,000 per year in 1890's. (Irelan 88:42; 90:111-112; Crawford 94:78-79; 96:75; Storms 00:83-84; Tucker 14:41; Logan 27:195; 34:106.)
44	Pioneer Lucky Strike	J.H. Hauhuth, Pioneer Station	20	7N	13E	MD	(Crawford 94:78; 96:73; Tucker 14:37-38; Logan 27:172; herein.)
	Pitts	William B. Pitts, Pine Grove	4	6N	12E	MD	See Mountain King.
45	Plymouth Consolidated	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	11	7N	10E	MD	(Hanks 86: pt. II 15-16; Irelan 88:42-49; 90:117; 93:79; Crawford 94:79; 96:75; Storms 00:82-83; Tucker 14:37,41-43; Logan 21:411; 22:24; 23:301; 23:16,73; 24a:3; 24c:177; 27:179-180; Knopf 29:6-7,49-51; Logan 34:106-111; Jenkins 48:65; herein.)
	Plymouth-Eureka	Richard Hosking, c/o B.H. Richardson, Box 387, Placerville	3	7N	10E	MD	In metavolcanics, 50-ft. shaft, active in 1914. (Tucker 14:43; Logan 27:195; 34:122.)
	Pocahontas	W.F. Detert Estate 1715 Mills Tower, San	24	7N	10E	MD	3 veins in slate, 620-ft. vertical shaft with 6 levels active in 1900. (Irelan 90:122-123; Storms 00:83; Tucker

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Pocahontas (cont'd)	Francisco					14:44; Logan 27:195; 34:122.)
	Podesta	Julius Podesta, Jackson	21	6N	12E	MD	Quartz vein with pyrite and chalcopyrite in greenstone, worked intermittently by Bert Contini of Pine Grove.
	Price (Prize)	Tony Levaggi, Plymouth	26	8N	10E	MD	7-ft. vein with greenstone hanging wall and slate footwall, 4 shallow shafts. (Irelan 90:120-121; Logan 27:195; 34:122.)
	Providence	W.F. Detert Estate 1715 Mills Tower, San Francisco	14	7N	10E	MD	(Logan 35:122.)
	Quartz Mountain		19	7N	11E	MD	See Gold Mountain.
46	Rainbow	Claude Hanley, 1727 Hiawatha Ave., Stockton	32	7N	12E	MD	Herein.
	Red Cloud	K. Pierovich, Jackson	35	8N	10E	MD	6-ft. vein with greenstone foot wall, slate hanging wall 200-ft. ore shoot, 275-ft. shaft. (Irelan 90:119-120; Crawford 96:75-76; Storms 00:85; Tucker 14:45; Logan 27:195.)
47	Red Hill	Claude Hanley, 1727 Hiawatha Ave., Stockton	32	7N	12E	MD	Herein.
	Red Tape	Marie R. North, 2008 Birch St., San Carlos	32	7N	13E	MD	North trending vein in granodiorite, 110-ft. shaft, 500-ft. adit. Active in 1914. (Tucker 14:45; Logan 27:195.)
	Rhetta						See Amador Star.
	Rising Star	B. Monte Verda and E.C.	11	7N	10E	MD	Part of Plymouth Consolidated.

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rising Star (cont'd)	Taylor, 369 Pine St. San Francisco					
	Robinson						See Fort Ann.
	Sargent	East Bay Municipal Utility District, Oakland	10	5N	11E	MD	N. 10° W. vein in slate and diorite, 120-ft. inclined shaft 700 ft. of underground workings. (Irelan 90:107; Tucker 14:45; Logan 27:195; 34:122.)
	Schoolhouse						See Amador Gold.
	Seaton	Hobart Estate Co. and Emma Rose, 202 Hobart Bldg., San Francisco	24	7 N	10 E	MD	Massive quartz vein on slate-metavolcanic contact, 950-ft. inclined shaft. (Irelan 88:42; Crawford 96:76; Tucker 14:45; Logan 27:195; 34:122.)
	Shakespeare	John F. Davis Estate 2872 Jackson St., San Francisco	11	7 N	10 E	MD	Two veins in slate, 27-ft. shaft, 100-ft. adit. (Irelan 90:121-122; Logan 27:195; 34:122.)
	Somerset	Bow Bridge Development Co., c/o E. Putman, Box 1069, Greenwich, Connecticut	32	7N	13E	MD	
	South Cosmopolitan Group	W.F. Detert Estate 1715 Mills Tower, San Francisco	24	7 N	10 E	MD	Northwest trending vein on diorite-slate contact, 195-ft. adit, 310-ft. inclined shaft. Active in 1888. (Irelan 88:49; Logan 27:196; 34:123.)
48	South Eureka	South Eureka Mining Co. c/o A.J. Mayman, 400 California St., San Francisco	17	6N	11E	MD	(Irelan 90:113; 93:144; Crawford 94:79; 96:76-77; Storms 00:63-64; Tucker 14:45-47; Logan 27:180-182; Knopf 29:62-63; Logan 34:111-114; Jenkins 48:64; herein.)
	South Jackson	South Jackson Mining	28	6N	11E	MD	3 veins in slates and amphibolite schist, 577-ft. verti-

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	South Jackson (cont'd)	Co., c/o J. Schweitzer Jackson					cal shaft, 3 levels 2100 feet underground workings, much development work done in 1913-1914. (Tucker 14:47-48; Logan 27:196; 34:114.)
	South Keystone	Keystone Mining Co. c/o John D. Culbert Amador City	6	6N	11E	MD	Irelan 90:115; Storms 00:77; Logan 27:196; 34:114,123.)
49	South Spring Hill	Keystone Mining Co. c/o John D. Culbert Amador City	31	7N	11E	MD	(Hanks 86:18; Irelan 88:71,80-84; 90:73,98,99; 92:145; Crawford 94:79; 96:74,77; Storms 00:77; Tucker 14:48; Logan 27:182; 34:91,123; Jenkins 48:65; herein.)
	Spagnoli	Mrs. Dorothy Ferguson and D.S. Richmond, Waterman	9	6N	12E	MD	Some work done on tailings during 1938. (Storms 00:45; Logan 27:185,196.)
	St. Julian (St. Junian)	Anthony B. Caminetti Jackson	10	5N	11E	MD	(Crawford 96:77; Tucker 14:48; Logan 27:196; 34:135.)
	Sunset		9	5 N	11 E	MD	See Argonaut. (Root 24:75; Logan 27:196.)
	Tellurium	Dr. F. O'Neil, Oroville and C.Brockman West Point	33	7 N	12 E	MD	Some work done during 1934 and 1945. (Crawford 94:79; Crawford 96:77; Tucker 14:49; Logan 27:197; 34:123.)
	Templeton	Mrs. Mary Templeton c/o Mrs. J. Gabs, 1112 Pacific Ave., Alameda	2	7N	10E	MD	
	Tom and Dick	Bow Bridge Development Co., c/o E. Putman, Box 1069, Greenwich, Connecticut	32	7N	13E	MD	

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
50	Treasure	Treasure Mining Co. 220 Montgomery St. San Francisco	25	7N	10E	MD	(Crawford 96:77-78; Tucker 14:49-50; Logan 21:411-412; 23:300; 23:16; 27:183-184,197; 34:123,199; Jenkins 48: 65; herein.)
	Trench	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	32	13N	7E	MD	
	Trencher	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York, New York	32	13N	7E	MD	
	Tri Mountain	The Knight Company Sutter Creek	22	7N	12E	MD	
	Triumph	Helen Crotty, Sutter Creek	6	6N	11E	MD	See Golden Eagle.
51	Valpariso	Valpariso Mining Co. Jackson	10	5N	11E	MD	Irelan 88:42; Crawford 94:79; 96:78; Tucker 14:52; Logan 27:197; 34:114-115,123; herein.)
	Victoria	Richard D. Dixon et al 425-4th St., Santa Rosa	11,24	7N	10E	MD	(Logan 34:123.)
	Volunteer	B. Monte Verda and E.C. Taylor, 369 Pine St. San Francisco	20	6N	11E	MD	(Irelan 90:105; Logan 27:197; 34:123.)
	Wabash	Nevada Wabash Mining Co., Box 504, Sutter	6	6N	11E	MD	(Logan 27:197; 34:123.)

GOLD, LODE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Wabash (cont'd)	Creek					
	West Eureka		7	6N	11E	MD	See Central Eureka. (Tucker 14:52; Logan 27:197; 34:123.)
	West Somerset	West Point Consolidated Mines Co., c/o E.H. Outerbridge, 250 Park Ave., New York New York	29	7N	13E	MD	
	White Mountain	Harbison and Walker Mining Co., 1800 Farmers Bank Bldg., Pittsburg, Pennsylvania	19	7N	11E	MD	(Logan 27:197; 34:123.)
52	Wildman						See Lincoln Consolidated.
	Wonder	Keystone Mining Company, c/o John D. Culbert, Amador City	36	7N	10E	MD	Herein.
53	Zeila (Zeile)	Mark and Frances Eudey, Martell	28	6N	11E	MD	(Hanks 86:22-23; Irelan 88:22,68,85,88; 90:68,104; 92:139; Crawford 94:80; 96:79; Storms 00:45,50; Tucker 14:52; Logan 27:184-185,197; 34:115-116, 123; Jenkins 48:62; herein.)

GOLD, PLACER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Amador Dredging Co.	Amador Dredging Co. Ione					Operated dragline dredge in Ione district part of 1941. (Averill 46:231.)
	Arroyo Seco Gold Dredging Company	Arroyo Seco Gold Dredging Co., 351 California St., San Francisco					Operated electric connected-bucket dredge from Jan. 1 to May 15, 1941. Also operated throughout 1940 at property 3 miles west of Ione and in 1935. (Averill 46:231.)
	Carlson and Sandburg						Operated dragline dredge east of the Ione city limits in 1939.
	Columbus Gold Gravel (Drift)	Charles W. Cassinelli et. al., c/o A. Marrie 643 Chetwood St., Oakland	9	7N	12E	MD	
	Comanche Gold Dredging Company						Worked deposit 1 mile north of Mokelumne River in Camanche district in the fall of 1935.
	Cuffe, Frank						Operated dragline dredge on South Fork of Consumnes River 1937-39.
54	Delta Placer Gold	Glen O'Brien, Ione	10	5N	9E	MD (proj.)	Herein.
	Diebold Ranch						L.E. Pearson of San Francisco operated a dryland dredge near Camanche in 1942.
55	Elephant hydraulic		15	7N	12E	MD	$1\frac{1}{2}$ to 3 feet of gravel on decomposed slate bedrock overlain by 40 to 45 feet of volcanic ash. Worked in 1922-23, 1927, and 1932. (Logan 27:198; Averill 46:231.)
	Flower Gold Recovery Co.						Operated dragline and dryland plant near Ione in 1938-39.

GOLD, PLACER, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
56	Garibaldi dredge	Frank and Pete Garibaldi, Volcano	23	7N	12E	MD	(Averill 46:231; herein.)
	Gold Hill Dredging Co.						Operated 5 cubic ft. dredge with 150,000 yards per month capacity in 1935 at Frank Collins property in Arroyo Seco.
	Henry and Weaver	Allen Ranch property					Operated dragline dredge in Sutter Creek gulch part of 1941. (Averill 46:231.)
	Horseshoe Dredging Co.	Horseshoe Dredging Co. Ione					Operated dragline dredge in Ione district May to July 1940. (Averill 46:231.)
	Horton	H.G. Kreth, Ione					Hydraulicked Horton mine in Jackson Valley, 5 miles south of Ione during parts of 1941. (Averill 46:231.)
	Humphreys Gold Corporation	Humphreys Gold Corporation, Denver, Colorado					Operated dry-land dredge near Carbondale in 1938.
	Irish Hill	McQueen and Downing 1040 38th Street, Sacramento					Operated dragline dredge from March 28 to June 25, 1941. (Averill 46:232.)
	Independence Gold Mines	Independence Gold Mines					Operated stationary washing plant in Camanche district between July 30 and October 12, 1941. (Averill 46:231.)
	Kate Gray	Mary and Albina Deluchi, Volcano	14	7N	12E	MD	
	Kent Dredging Company	E.A. Kent, 351 California St., San Francisco					Operated two dragline dredges on Sutter Creek between Volcano and Sutter Creek during 1940. (Averill 46:232.)
	Lagomarsino drift tunnel	D. Hendrickson, Oakland (lessee)					Some work done in late 1933 and early 1934.

GOLD, PLACER, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lancha Plana Gold Dredging Company	Lancha Plana Gold Dredging Co., La Lomita Rancho, Lockeford					Operated electric connected-bucket dredge on Jackson Creek near Buena Vista throughout 1940 and Jan. to May, 1941. Also worked on Stony Creek half way between Ione and Jackson during 1937.
57	Lilly dredge	E.L. Lilly, 1640 East Poplar St., Stockton 5	24	8N	9E	MD	(Logan 46:233; herein.)
			20,28, 29	8N	10E	MD	
	Long Bar Gold Dredging Company	Lorentz property					Operated dragline dredges on Consumnes River in 1942. (Averill 46:232.)
	Lorentz and Swingle	Lorentz property					Operated on Consumnes River; 7 miles northwest of Plymouth in 1941. (Averill 46:232.)
58	Madrill Dredge	C.R. and Annabelle C. Brown, R.F.D., Ione	6	4N	10E	MD	Herein.
	McDonald dredge						Operated dragline dredge on Dry Creek in August 1949.
	Mountain Gold Dredging Company	Mountain Gold Dredging Company, Plymouth					Operated dragline dredge on Matulich property near Drytown intermittently during 1941. Also operated on Detert Estate in Plymouth district on Indian Creek in 1941. (Averill 46:232.)
	Orr, Elwood						Elwood Orr was in charge of a placer operation 3 miles north of Plymouth in the middle part of 1936. Treated between 200 to 250 cubic yards per day.
	Pacific Placers Engineering Company	Pacific Placers Engineering Co., Sacramento					Operated dragline dredge on McColloh property in Ione district during parts of 1940-41. (Averill 46:232.)
	Pantle, J.C.	J.C. Pantle, Lincoln					Operated dry-land dredge on Willow Creek 5 mi. west of Drytown from 1940 to Oct., 1942. (Averill 46:232.)

GOLD, PLACER, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
59	Pigeon drift	Fred N. Pigeon, Fiddletown	28	8N	11E	MD	(Tucker 14:41; herein.)
	Placeritas Mining Co.	Placeritas Mining Co. 245 N. Gramercy Place Los Angeles					Operated dragline dredge on six different properties within 4 mile radius of Plymouth. (Averill 46:232.)
	Plymouth Gold Dredging Company	Plymouth Gold Dredging Company, Plymouth					Operated dryland plant in Plymouth area during part of 1940.
	R. & M. Mining Company	R. & M. Mining Company Plymouth					Operated dragline dredge, beside State Highway 49, 2 mi. north of Plymouth in 1938.
	Raymond Mining Co., 114 N. Westmoreland Ave., Los Angeles 4.	Frank P. & Annie Dal Porto, Plymouth	SW$\frac{1}{4}$ SE$\frac{1}{4}$ 6 NW$\frac{1}{4}$ NE$\frac{1}{4}$ 7	7N	11E	MD	This company leased gravel beds along N. Fork of Dry Creek in Feb. 1952.
	Rendell	Lee and Lillie A. Payton, Pine Grove	35	7N	12E	MD	
	Rim Cam Gold Dredging Co.	Yager Ranch					Operated dragline dredge in Ione district from Feb. 4 to May 26, 1941. Also operated near Drytown on Consumnes River between Plymouth and Nashville in 1940. (Averill 46:232,233.)
	River Pines Mining Co.	River Pines Mining Co. Plymouth					Operated dragline dredge near Aukum from Jan. to June 12, 1941. This was the most productive dragline dredge in the County in 1940. (Averill 46:232.)
	San Andreas Gold Dredging Company	San Andreas Gold Dredging Co., 960 Russ Bldg. San Francisco					Operated dragline dredge on Arroyo Seco Ranch during part of 1940. (Averill 46:232.)

GOLD, PLACER, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
60	Secor dredge	Evans, Elmer, c/o County Treasurer's Office, Jackson	18	7N	12E	MD	(Herein.)
	Stock, Lee						Operated dragline dredge on Dry Creek on Rancho Arroyo Seco between Waits Station and Ione in 1949. The outfit handled 70 cubic yards per hour.
	Treble Clef	E.L. Lilly, 706 California Bldg., Stockton					Operated dragline dredge during parts of 1941. This outfit was operated throughout 1940 on 2 different properties. (Averill 46:233.)
	Union Flat	Chester Bonneau Charles Guilian and James Giannini					Property worked during 1927. Some hydraulicking was done under lease during 1938. Some clean-up work was done in 1936. Lagomarsino hydraulicked property from March through May 1949. (Logan 27:199.)

IRON

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
61	Arroyo Seco		27 28	6N	9E	MD (proj.)	(Aubury 06:364; Tucker 14:52; Logan 27:199; herein.)
62	Clinton (Irishtown)		8,9	6N	12E	MD	(Aubury 06:364; Tucker 14:52; Logan 27:199; herein.)
63	Thomas	George M. Thomas, Jackson	16 17	5N	10E		Herein.

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Alexander	Darrow A. Russell, et al., Amador City	29	7N	11E	MD	Bed of manganiferous and ferruginous chert in slate. (Jenkins 43:75; Trask 50:27)
	Big Gulch	State of California	NW¼ 4	7N	12E	MD	Old hydraulic gold property. Low-grade manganese oxide in lateritic soils beneath Tertiary lava cap. (Jenkins 43:75; Trask 50:27.)
	Custer (Dooley)	R.B. Custer, et al., c.o R.J. Custer, Route 2, Box 1077, Stockton	28	6N	10E	MD	Manganiferous metachert enclosed in metavolcanics and metatuffs. (Jenkins 43:75; Trask 50:27-28.)
	Deaver	E.E. Hutchinson, et al. 207 Union Street, Placerville	31	8N	12E	MD	A few blocks of manganiferous metachert exposed in road-cut. (Trask 50;28.)
64	DuFrene	Fred DuFrene, et al. Ione	SW¼ 27	6N	10E	MD	A bed of manganiferous metachert five to eight feet thick is exposed for a length of 270 feet. Worked by small shaft and series of open cuts. (Jenkins 43:75; Trask 50:28-29.)
	Eagle's Head	State of California	N½ 4	7N	12E	MD	Concentrations low-grade manganese oxide in lateritic soils beneath Tertiary lava cap. (Jenkins 43:75; Trask 50:29.)
	Germolis (Rodonick)	Paul Germolis, et al. Fiddletown	NW¼ 10	7N	11E	MD	A development cut exposes bed of massive, manganiferous metachert containing pockets 3-4 inches wide of high-grade ore. The average analysis for the bed is probably around 20% Mn. (Jenkins 43:75; Trask 50:30.)
	Jones	D.C. Stowe, 620 East Charter Way, Stockton	32	7N	12E	MD	Manganiferous metachert. The ore is chiefly botryoidal and nodular psilomelane with some pyrolusite worked by 30-foot shaft and open cuts. Last work was World War I but no ore shipped. (Trask 50:30-31.)

MANGANESE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lubanko	Louis Lubanko, Fiddletown	SE¼ 10	7N	11E	MD	(Jenkins 43:75; Trask 50:31; herein.)
65	Perini (Peyton et al. lease)	Benjamino Perini, Pine Grove	NW¼ 35	7N	12E	MD	(Bradley et al., 18:30; Logan 27:201; Trask 50:31-32; herein.)
66	Peyton (Crocker-Preston property)	Benjamino Perini, Pine Grove	SW¼ 35	7N	12E	MD	(Bradley et al., 18:29; Logan 27:200; Trask 50:32-33; herein.)
	Ruhser and Hubberty		29?	7N	13E	MD	(Bradley et al., 18:30; Logan 27:201; Jenkins 43:75; Trask 50:33.)
	Stirnaman	J.L. and L.C. Wells 716 Wagner Avenue Stockton	SE¼ 24	7N	12E	MD	(Logan 27:201; Jenkins 43:75; Trask 50:34-35; herein.)

COAL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
71	American Lignite Products Co.	Maud May Fithian (1945) (Operated by American Lignite Products Co., Ione)	SE$\frac{1}{4}$ 26	6N proj	9E	MD	(Jenkins 49:35; 50:62; 51:311; herein)
72	Buena Vista	Leased by American Lignite Products Co., Ione	NE$\frac{1}{4}$ 19	5N	10E	MD	Last period of continuous operation was from 1925 to 1938. Coal was mined by underground methods off two shafts. (Tucker 14:11; Logan 21:413, 27:146)
73	Carbondale	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco	NE$\frac{1}{4}$ 5	6N	9E	MD	At Carbondale. Lot 324, Rancho Arroyo Seco. (Irelan 92:148) Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.
74	Coal Mine No. 1	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco	NE$\frac{1}{4}$ 35(?)	6N proj	9E	MD	Lot 259, Rancho Arroyo Seco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.
75	Coal Mine No. 2	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco	S$\frac{1}{2}$ 26	6N proj	9E	MD	Lot 437, Rancho Arroyo Seco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.
76	Coal Mine No. 3	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and	NE$\frac{1}{4}$ 16	6N proj	9E	MD	Lot 237, Rancho Arroyo Seco. 0.5 of a mile northwest of Clarksona. (Irelan 88:110-112; 92:147; Crawford 94:41, 96:51; Logan 27:148)

COAL, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
76	Coal Mine No. 3 (cont'd)	Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date					
77	Coal Mine No. 4	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date	SW$\frac{1}{4}$ 4	6N proj	9E	MD	Lot 232, Rancho Arroyo Seco. 1 mi. E. of Carbondale $\frac{1}{4}$ mile N. of RR. (Tucker 14:12; Logan 27:147)
78	Harvey		NE$\frac{1}{4}$ 32	7N	9E	MD	1 mi. N. of Carbondale at May. (Tucker 14:11; Logan 21:413; 27:147)

CRUSHED ROCK, SAND & GRAVEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Ayers, Charles, Sutter Creek	Central Eureka Mining Company, Russ Building San Francisco	8	6N	11E	MD	Dry bar run stream gravels from Sutter Creek have been produced intermittently since early 1930's. Last production was during 1948. The amount and time of production depend upon the market. A $\frac{1}{4}$ yard dragline is on the property.
68	Alpine Gravel Plant	Jack Bacigalupi, Pine Grove	NE$\frac{1}{4}$				Herein.
			SW$\frac{1}{4}$ 22	6N	11E	MD	Herein.
69	Relvas gravel	E.J. Relvas, Ione	14,15	6N	9E	MD (proj.)	Herein.
70	Sacramento County sand pit	Louis G., Cora J., and Gene L. Klotz, Freeport Blvd., Rt. 8, Box 1380, Sacramento 17	SW$\frac{1}{4}$ 5	7N	9E	MD	Herein.

LIMESTONE & MARBLE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
79	Allen Estate	John B. and George Allen, Sutter Creek	11	6N	10E	MD	Of a number of limestone outcrops, only few show promise. One of outcrops worked in late 1945 by A. Teichert & Son, Inc. of Sacramento (Analysis herein).
	Amador Marble						See Dal Porto marble. (Aubury 06:96; Tucker 14:53; Logan 27:200; 47:209)
	Amador Lime Rock	Pacific Portland Cement Co., 417 Montgomery St., San Francisco	16	6N	10E	MD	Worked in small way from 1859 to 1910; shallow pits on property. Limestone is light gray, compact, finely crystalline. (Aubury 06:64; Logan 47:208)
	Garibaldi Ranch	Theresa Garibaldi, Amador City	N½ 33	7N	10E	MD	Main limestone outcrop is 120 feet wide and 930 feet long. High magnesian content. No work has been done. (Logan 47:210; analysis herein)
80	Dal Porto Marble	Frank P. Dal Porto, Plymouth	S½ SW¼ and SW¼SE¼ 6	7N	11E	MD	Worked in 1880 or earlier producing marble. Property has quarry face 90 feet, waste dump 200 feet long and 40 feet wide. Best marble 50 feet wide in center with white to dark gray color. (Aubury 06:97; Tucker 14:53; Logan 27:200, Logan 47:209; analysis herein)
81	Dondero Marble	Aurelio G. Dondero, 852 59th St., Oakland	N½ 29	7N	12E	MD	(Aubury 06:96-97; Tucker 14:53; Logan 27:200, 47:209; analysis herein)
	Ellis Bros. Ranch	J.M. and F.J. Ellis, Box 98, Jackson	30	6N	11E	MD	No work done; several limestone outcrops.
	Fiddletown	Pacific Portland Cement Co., 417 Montgomery St., San Francisco	5,6 7	7N	12E	MD	Large and irregular limestone outcrops. Deposit partly covered by andesite and gravel, partly by soil. Undeveloped. (Logan 47:210; analysis herein)
	Greilich Ranch (Grelich Ranch)	Geo. E. & Eleanor Grelich, Plymouth	5,8	7N	10E	MD	Main limestone outcrop 450 feet long, 50 to 85 feet wide. Limestone is finely crystalline and gray in color. Undeveloped. (Logan 47:211; analysis herein)

LIMESTONE & MARBLE, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Oleta marble						See Dal Porto marble.
82	Volcano Limestone	Great Western Lands Development Co. c/o J.J. Lerman, 806 Balboa Bldg. San Francisco	23	7	12	MD	Six diamond drill holes drilled 1928. Probably largest high-calcium, low-magnesium limestone in Amador Co. Undeveloped (Logan 27:200, 47:211; analyses herein)
	Wait Marble	Greilich Bros., Drytown	21	7	10	MD	Marble is hard, durable, and takes a high polish, having cherry red color due to iron oxides. It crops out over area 160 x 400 feet. One hole drilled 1924. (Logan 27:300 47:212)

PUMICE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
67	Bacon Pit	Charles S. Howard Estate, c/o Crocker First National Bank San Francisco	$SE\frac{1}{4}$ 19	6N (proj.)	9E	MD	(Jenkins 50:193; herein.)

REFRACTORY MATERIALS
CLAY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
83	Airplane	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and M Montgomery Sts., San Francisco. Leased to Gladding McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NW$\frac{1}{4}$ 15	6N (proj)	9E	MD	(Bates 45:6,24; Johnson 48:1-6; 49:491-498; herein.)
84	Amick	State of California, Preston School of Industry, Waterman	23 24 (?)	6N (proj)	9E	MD	Half a mile west of Ione. Formerly operated by W.D. Amick, Ione, and Philadelphia Quartz Company, Berkeley. Ione sand from the lower member of the Ione formation. Sandy clay was washed to produce china clay and glass sand. Open pit. Idle. (Tucker 14:9-10; Boalich 20:39-42; Logan 21:413, 23:95; Dietrich 28:63; Sampson and Tucker 31:433-34.)
	Bacon Red						See Ione Red.
85	Baker Hill	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco	NE$\frac{1}{4}$ 9	6N (proj)	9E	MD	Lot 234, Rancho Arroyo Seco. $4\frac{1}{2}$ miles N. 45° W. of Ione. Fire clay (P.C.E.: cone 33-34) from the lower member of the Ione formation. Ceased operation about 1944. Open pit. Idle. (Tucker 14:11; Logan 27:135; Dietrich 28:pl. 6)
	Barber						See Shepard.
	Carlile clay and sand						See Solari.
86	Chalk Hill	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and	SE$\frac{1}{4}$ 10	6N (proj.)	9E	MD	Lots 222 and 223, Rancho Arroyo Seco. 3 miles N. 40° W. of Ione. Fire clay (P.C.E.: cone 33) from the lower member of the Ione formation. Similar to Cheney Hill clay. Open pit. Idle. (Bates 45:6, 24)

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
86	Chalk Hill (cont'd)	Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.					
87	Cheney Hill	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date	SW$\frac{1}{4}$ 35	6N (proj.)	9E	MD	(Bates 45:5-6, 24-26; herein)
88	China Gulch		NW$\frac{1}{4}$ 32	5N	10E	MD	On the west side of China Gulch 1.8 miles N. 16° W. from Lancha Plana. Fire clay (P.C.E.: cone 33) from the lower member of the Ione formation. Cheney-Hill-type clay according to Bates but possibly Edwin-type clay. Open pit and adits. Idle. (Bates 45:5-6, 24)
89	Chitwood	C.W. Chitwood (1945)	SE$\frac{1}{4}$ 13	5N (proj.)	9E	MD	1.2 miles S. 55° W. from Buena Vista. Chitwood clay from the upper member of the Ione formation. A gray sandy clay with a P.C.E. of cone 30-31. Open pit. Idle. (Bates 45:6, 24; Pask 52:21,23)
90	Chocolate (Harvey)	M.J. Bacon, Ione (1928)	NE$\frac{1}{4}$ 32 (?)	7N	9E	MD	Apparently the pit 0.6 mile north of Carbondale. Clay from the lower member of the Ione formation. Open pit. Idle. (Logan 27:135; Dietrich 28:57, 280)
	Clark						(See Dosch)

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
91	Clark Sand	Pacific Clay Products Co. Box 145, Sta. A, Los Angeles 31	SW$\frac{1}{4}$ 28	7N	9E	MD	(Aubury 06:208; Tucker 14:6; Logan 27:136; Dietrich 28:58, 261; Sampson and Tucker 31:435; herein.)
92	Deutschke	Charles J. Deutschke Ione, (1945)	N$\frac{1}{2}$ 21	6N (proj.)	9E	MD	Herein.
93	Dosch (Clark)	Pacific Clay Products Co. Box 145, Sta. A., Los Angeles 31	N$\frac{1}{2}$ 15	6N (proj.)	9E	MD	(Irelan 88:108; Tregloan 03:13-14; Aubury 06:207-208; Tucker 14:5-6; Boalich 20:38; Logan 23:96, 27:136; Dietrich 28:58, 302,312; Allen 29, 359; Bates 45:6, 24; herein.)
94	Edwin (Jones Butte) Pit No. 1 Pit No. 2 Pit No. 3 Pit No. 4 Mine No. 1 Mine No. 2 Mine No. 3 Mine No. 4	Charles S. Howard Estate, Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1944 to date.	S$\frac{1}{2}$ 16 N$\frac{1}{2}$ 21	6N (proj.)	9E	MD	(Logan 27:141-42; Dietrich 28:53-54; Schuette 29:196-198; Bates 45:1-38; herein.)
95	Fancher	J.M. Fancher, Ione	SE$\frac{1}{4}$ 12	5N (proj.)	9E	MD	1 mile N. 77° W. of Buena Vista. Fire clay from the Cheney Hill bed in the lower member of the Ione formation. Open pit and adits. Idle. (Logan 23:96; Logan 27:141; Dietrich 28:59,280; Bates 45:6, 24; Pask 52:17,19,23)
96	Farci	Antoni Farci, Ione. Leased to Western Refractories Co., Russ Bldg., San Francisco since 1950	SW$\frac{1}{4}$ 5	5N	10E	MD	Herein.

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Free						See King and Enos.
	Gage						See Irish Hill.
	Hammer	Fred Hammer, Carbondale (1896)					At Carbondale. Mined clay for use in the Carbondale Pottery at May and to sell. Operated from 1877 through 1896. (Watts 93:149; Crawford 96:613.)
	Harvey						See Yosemite and Chocolate.
97	Ione Fire Brick	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NW$\frac{1}{4}$ 36	6N (proj.)	9E	MD	Lot 273, Rancho Arroyo Seco. 1 mile south of Ione and just west of the Shepard pit. Clayey sand from the Ione Sand bed in the lower member of the Ione formation. Open pit. Active in 1928. Now idle. (Logan 27:138-141; Dietrich 28:56,280)
	Ione Fire Brick Company Plant						See Western Refractories Company Plant.
98	Ione Red (Bacon Red) (Lane Mottled)	Mrs. M. J. Bacon, Ione Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NW$\frac{1}{4}$ 32	6N	10E	MD	(Logan 27:135; Dietrich 28:57,335; Bates 45:6,24; herein)
99	Ione Sand	Charles S. Howard Estate, c/o Crocker First National Bank of San	N$\frac{1}{2}$ 36	6N (Proj.)	9E	MD	Herein.

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
99	Ione Sand (cont'd)	Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	N$\frac{1}{2}$ 36	6N	9E	MD (proj.)	Herein.
100	Irish Hill (Gage)	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NE$\frac{1}{4}$ 10	6N	9E	MD (proj.)	Lot 224, Rancho Arroyo Seco. 3.9 miles N. 31° W. of Ione. Residual clay in the Mariposa slate. Open pit. Idle. (Aubury 06:208-210; Tucker 14:11; Logan 27:135; Dietrich 28: 52-53,273).
	Jones Butte						See Edwin.
101	Kaolin-Fye	Calaveras Cement Company, 315 Montgomery St., San Francisco 6 and Pearl T. Fye. Leased to Calaveras Cement Company	SW$\frac{1}{4}$ 8	5N	10E	MD	(Pask 52:19,23; herein)
102	King and Enos (Free)	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz	N$\frac{1}{2}$ 5	6N (proj.)	9E	MD	Lot 324, Rancho Arroyo Seco. 200 yards west of Carbondale. Soft, plastic, light blue, refractory clay, with no sand, in the lower member of the Ione formation. Clay bed from 6 to 14 feet thick. Average annual production in 1906 was about 9000 tons. Open pit. Idle. (Watts 93:149; Tregloan 03:13-14; Aubury 06:208; Tucker 14:11)

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
102	King and Enos (Free) (cont'd)	Blvd., Los Angeles 26, from 1948 to date.					
	Lane mottled						See Ione Red.
103	Laterite	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	W½ 16	6N	9E (proj.)	MD	(Dietrich 28:54; Allen 29:383-394; Bates 45:13-15; herein)
104	Newman	Nettie V. Gradwohl (1945). Leased to Western Refractories Co., Russ Bldg., San Francisco	NW¼ 31 SW¼ 30	6N	10E	MD	1.0 mile S 18° E. of Ione on both sides of the Amador Central railroad. Clayey sand from the Ione Sand bed in the lower member of the Ione formation. Average annual production during the 1920's about 6000 tons. Open pit and room and pillar stopes. Idle since 1934. (Tucker 14:7-9; Boalich 20:38; Logan 23:96; Logan 27:140-141; Dietrich 28:61-63, 261,290,335; Allen 29:440; Sampson and Tucker 31:435)
105	Newman Red	Nettie V. Gradwohl (1945). Leased to Western Refractories Co., Russ Bldg., San Francisco	NW¼ 31	6N	10E	MD	(Logan 27:141; Dietrich 28:63,329; Bates 45:24; herein)
	Preston Brick plant	State of California, Preston School of Industry, Waterman	24	6N (proj.)	9E	MD	Several pits on state property. Intermittent production for use in common brick. Open pit. Currently idle.

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
106	Shepard (Barber)	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NE$\frac{1}{4}$ 36	6N (proj.)	9E	MD	Lot 261, Rancho Arroyo Seco. 1.0 mile S. 6° E. of Ione. Adjoins Newman pit on the west. Buff clayey sand about 16 feet thick from the Ione sand bed in the lower member of the Ione formation. Overburden of brown clayey sand 6 to 10 feet thick. Open pit and room and pillar stopes. Idle. (Logan 27:135-36; Dietrich 28:54-56, 261; Sampson and Tucker 31:434)
107	Smokey No. 1	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	SW$\frac{1}{4}$ 27	6N (proj.)	9E	MD	Lot 285, Rancho Arroyo Seco. 2.6 miles S. 73° W. of Ione. Edwin-type clay in the lower member of the Ione formation. Active about 1945. Open pit. Idle. (Bates 45:5,24)
108	Smokey No. 2	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	NW$\frac{1}{4}$ 34	6N (proj.)	9E	MD	Lots 283 and 284, Rancho Arroyo Seco. 2.8 miles S. 63° W. of Ione. Edwin-type clay in the lower member of the Ione formation. Active about 1945. Open pit. Idle. (Bates 45:5,24)
109	Smokey No. 3	Charles S. Howard Es-	SW$\frac{1}{4}$ 34	6N	9E	MD (proj.)	Lot 279, Rancho Arroyo Seco. 3.0 miles S. 57° W. of Ione.

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
109	Smokey No. 3 (cont'd)	tate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	34	6N (proj.)	9E	MD	Edwin-type clay in the lower member of the Ione formation. Active about 1945. Open pit. Idle. (Bates 45:5,24)
110	Solari (Carlile clay and sand)	E.E. Tremain, Buena Vista, via R.F.D., Ione	$W\frac{1}{2}$ $NW\frac{1}{4}$ 8	5N	10E	MD	3.6 miles S. 25° E. of Ione. Clayey sand from the Ione Sand bed in the lower member of the Ione formation. Active from 1927 to 1949. Open pit. Idle. (Logan 23:96; 27:136-137; Dietrich 28:57-58, 262; Sampson and Tucker 31:434-35)
	Tiger Creek	Winton Lumber Company, Martell	$SW\frac{1}{4}$ $SW\frac{1}{4}$ 23	8N	14E	MD	Herein.
111	Wallen	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	$SE\frac{1}{4}$ 6	5N	10E	MD	Lot 265, Rancho Arroyo Seco. 2.8 miles S. 23° E. of Ione. Clayey sand from the Ione Sand bed in the lower member of the Ione formation. Open pit. Idle.
112	Western Refractories Company Plant (Ione Fire Brick Company) Plant	Western Refractories. Company, Russ Bldg., San Francisco	$NW\frac{1}{4}$ 31	6N	10E	MD	1.4 miles S. 18° E. of Ione. Manufacture fire brick and ground fire clay. Active. (Tucker 14:11; Boalich 20:38; Logan 23:96; 27:138-141; Dietrich 28:60-61; Sampson and Tucker 31:435; herein)

CLAY, (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
113	Woolford	W.G. Woolford, R.F.D. Ione	NE$\frac{1}{4}$ 11	5N (proj.)	9E	MD	2.1 miles N. 70° W. of Buena Vista. Clay of the Cheney Hill type (with a P.C.E. of Cone 33+) in the lower member of the Ione formation. Open pit and adits. Idle. (Bates 45:5-6, 24; Pask 52:16, 23)
114	Yager	Myrtle E. Yager	NW$\frac{1}{4}$ 30	6N	10E	MD	0.6 of a mile S. 62° E. of Ione. Fire clay in the lower member of the Ione formation. Operated by Western Refractories Co. from approximately 1944 to 1950. Open pit. (Idle ?)
115	Yaru No. 1	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	SW$\frac{1}{4}$ 4	6N (proj.)	9E	MD	Lot 232, Rancho Arroyo Seco. 4.9 miles N. 45° W. of Ione. 100 yards north of Lignite Siding on the Southern Pacific railroad. Fire clay (Yaru No. 1) and red-burning clay (Yaru No. 2) in the lower member of the Ione formation. During the 1920's the average annual production was about 4000 tons. Open pit. Idle. (Logan 27:135; Dietrich 28:56, 302,335)
116	Yaru No. 2	Charles S. Howard Estate, c/o Crocker First National Bank of San Francisco, Post and Montgomery Sts., San Francisco. Leased to Gladding, McBean and Co., 2901 Los Feliz Blvd., Los Angeles 26, from 1948 to date.	N$\frac{1}{2}$ 10	6N (proj.)	9E	MD	Lot 224 and 225, Rancho Arroyo Seco. 3.9 miles N. 36° W. of Ione. Open pit. Idle. (Dietrich 28:plate 6)
117	Yosemite (Harvey)	Western Refractories Co., Russ Building, San Francisco	W$\frac{1}{2}$ 29	7N	9E	MD	(Logan 27:138; Dietrich 28:63,298; herein)

REFRACTORY MATERIALS
GLASS SAND

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
118	Custer (Grog)	E.W. Custer. Leased to Western Refractories Co., Russ Bldg., San Francisco	SE¼ 30	6N	10E	MD	Herein.
	Grog						See Custer.

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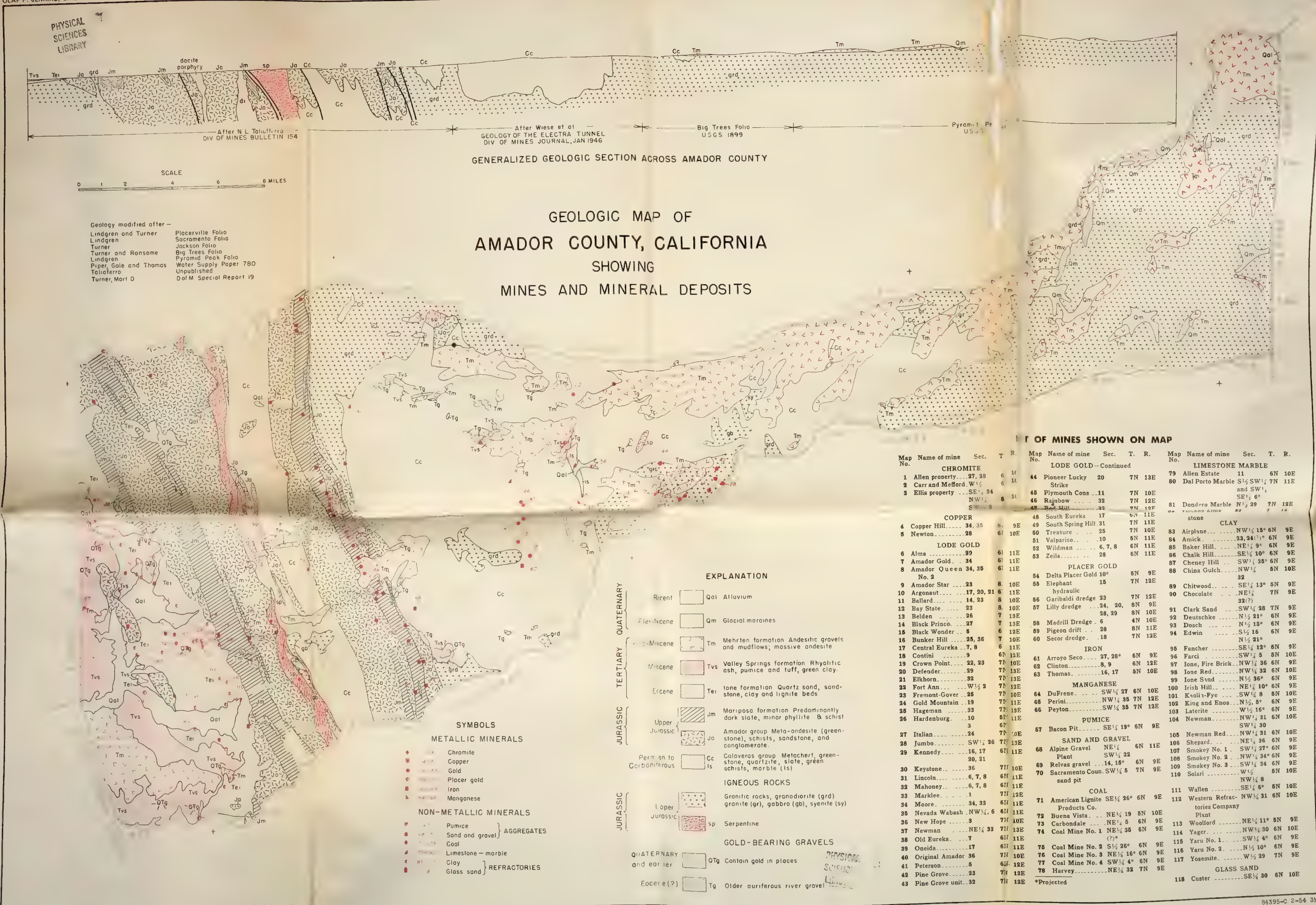

LIST OF MINES SHOWN ON MAP

Map No.	Name of mine	Sec.	T.	R.
	CHROMITE			
1	Allen property	27, 28	6	10
2	Carr and Mefford	W½	6	10
3	Ellis property	SE¼ 34 NW¼ SW¼ 2	5	10
	COPPER			
4	Copper Hill	34, 35	5	9E
5	Newton	28	6N	10E
	LODE GOLD			
6	Alma	29	6N	11E
7	Amador Gold	34	6N	11E
8	Amador Queen No. 2	34, 35	6N	11E
9	Amador Star	23	8	10E
10	Argonaut	17, 20, 21	6N	11E
11	Ballard	14, 23	8	10E
12	Bay State	23	8	10E
13	Belden	26	7	13E
14	Black Prince	27	7	13E
15	Black Wonder	5	6	12E
16	Bunker Hill	25, 36	7	10E
17	Central Eureka	7, 8	6	11E
18	Contini	9	6N	12E
19	Crown Point	22, 23	7N	10E
20	Defender	29	7N	13E
21	Elkhorn	32	7N	13E
22	Fort Ann	W½ 2	7N	12E
23	Fremont-Gover	25	7N	10E
24	Gold Mountain	19	7N	11E
25	Hageman	33	7N	13E
26	Hardenburg	10 3	5N 6N	11E
27	Italian	24	7N	10E
28	Jumbo	SW¼ 26	7N	13E
29	Kennedy	16, 17 20, 21	6N	11E
30	Keystone	36	7N	10E
31	Lincoln	6, 7, 8	6N	11E
32	Mahoney	6, 7, 8	6N	11E
33	Marklee	1	7N	12E
34	Moore	34, 33	6N	11E
35	Nevada Wabash	NW¼, 6	6N	11E
36	New Hope	3	7N	10E
37	Newman	NE¼ 33	7N	13E
38	Old Eureka	7	6N	11E
39	Oneida	17	6N	11E
40	Original Amador	36	7N	10E
41	Peterson	5	6N	12E
42	Pine Grove	23	7N	13E
43	Pine Grove unit	32	7N	12E
	LODE GOLD—Continued			
44	Pioneer Lucky Strike	20	7N	13E
45	Plymouth Cons	11	7N	10E
46	Rainbow	32	7N	12E
47	Red Hill	32	7N	12E
48	South Eureka	17	6N	11E
49	South Spring Hill	31	7N	11E
50	Treasure	25	7N	10E
51	Valpariso	10	5N	11E
52	Wildman	6, 7, 8	6N	11E
53	Zeila	28	6N	11E
	PLACER GOLD			
54	Delta Placer Gold	10*	5N	9E
55	Elephant hydraulic	15	7N	12E
56	Garibaldi dredge	23	7N	12E
57	Lilly dredge	24, 20, 28, 29	8N 8N	9E 10E
58	Madrill Dredge	6	4N	10E
59	Pigeon drift	28	8N	11E
60	Secor dredge	18	7N	12E
	IRON			
61	Arroyo Seco	27, 28*	6N	9E
62	Clinton	8, 9	6N	12E
63	Thomas	16, 17	5N	10E
	MANGANESE			
64	DuFrene	SW¼ 27	6N	10E
65	Perini	NW¼ 35	7N	12E
66	Peyton	SW¼ 35	7N	12E
	PUMICE			
67	Bacon Pit	SE¼ 19*	6N	9E
	SAND AND GRAVEL			
68	Alpine Gravel Plant	NE¼ SW¼ 22	6N	11E
69	Relvas gravel	14, 15*	6N	9E
70	Sacramento Coun. sand pit	SW¼ 5	7N	9E
	COAL			
71	American Lignite Products Co.	SE¼ 26*	6N	9E
72	Buena Vista	NE¼ 19	5N	10E
73	Carbondale	NE¼ 5	6N	9E
74	Coal Mine No. 1	NE¼ 35 (?)*	6N	9E
75	Coal Mine No. 2	S½ 26*	6N	9E
76	Coal Mine No. 3	NE¼ 16*	6N	9E
77	Coal Mine No. 4	SW¼ 4*	6N	9E
78	Harvey	NE¼ 32	7N	9E
	LIMESTONE MARBLE			
79	Allen Estate	11	6N	10E
80	Dal Porto Marble	S½ SW¼ and SW¼ SE¼ 6*	7N	11E
81	Dondero Marble	N½ 29	7N	12E
82	Volcano Limestone	23	7	12
	CLAY			
83	Airplane	NW¼ 15*	6N	9E
84	Amick	23, 24(?)*	6N	9E
85	Baker Hill	NE¼ 9*	6N	9E
86	Chalk Hill	SE¼ 10*	6N	9E
87	Cheney Hill	SW¼ 35*	6N	9E
88	China Gulch	NW¼ 32	5N	10E
89	Chitwood	SE¼ 13*	5N	9E
90	Chocolate	NE¼ 32(?)	7N	9E
91	Clark Sand	SW¼ 28	7N	9E
92	Deutschke	N½ 21*	6N	9E
93	Dosch	N½ 15*	6N	9E
94	Edwin	S½ 16 N½ 21*	6N	9E
95	Fancher	SE¼ 12*	5N	9E
96	Farci	SW¼ 5	5N	10E
97	Ione, Fire Brick	NW¼ 36	6N	9E
98	Ione Red	NW¼ 32	6N	10E
99	Ione Sand	N½ 36*	6N	9E
100	Irish Hill	NE¼ 10*	6N	9E
101	Kaolin-Fye	SW¼ 8	5N	10E
102	King and Enos	N½, 5*	6N	9E
103	Laterite	W½ 16*	6N	9E
104	Newman	NW¼ 31 SW¼ 30	6N	10E
105	Newman Red	NW¼ 31	6N	10E
106	Shepard	NE¼ 36	6N	9E
107	Smokey No. 1	SW¼ 27*	6N	9E
108	Smokey No. 2	NW¼ 34*	6N	9E
109	Smokey No. 3	SW¼ 34	6N	9E
110	Solari	W½ NW¼ 8	5N	10E
111	Wallen	SE¼ 6*	5N	10E
112	Western Refractories Company Plant	NW¼ 31	6N	10E
113	Woolford	NE¼ 11*	5N	9E
114	Yager	NW¼ 30	6N	10E
115	Yaru No. 1	SW¼ 4*	6N	9E
116	Yaru No. 2	N½ 10*	6N	9E
117	Yosemite	W½ 29	7N	9E
	GLASS SAND			
118	Custer	SE¼ 30	6N	10E

*Projected

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

Volume 50, Number 2
APRIL 1954

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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

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DIVISION OF MINES
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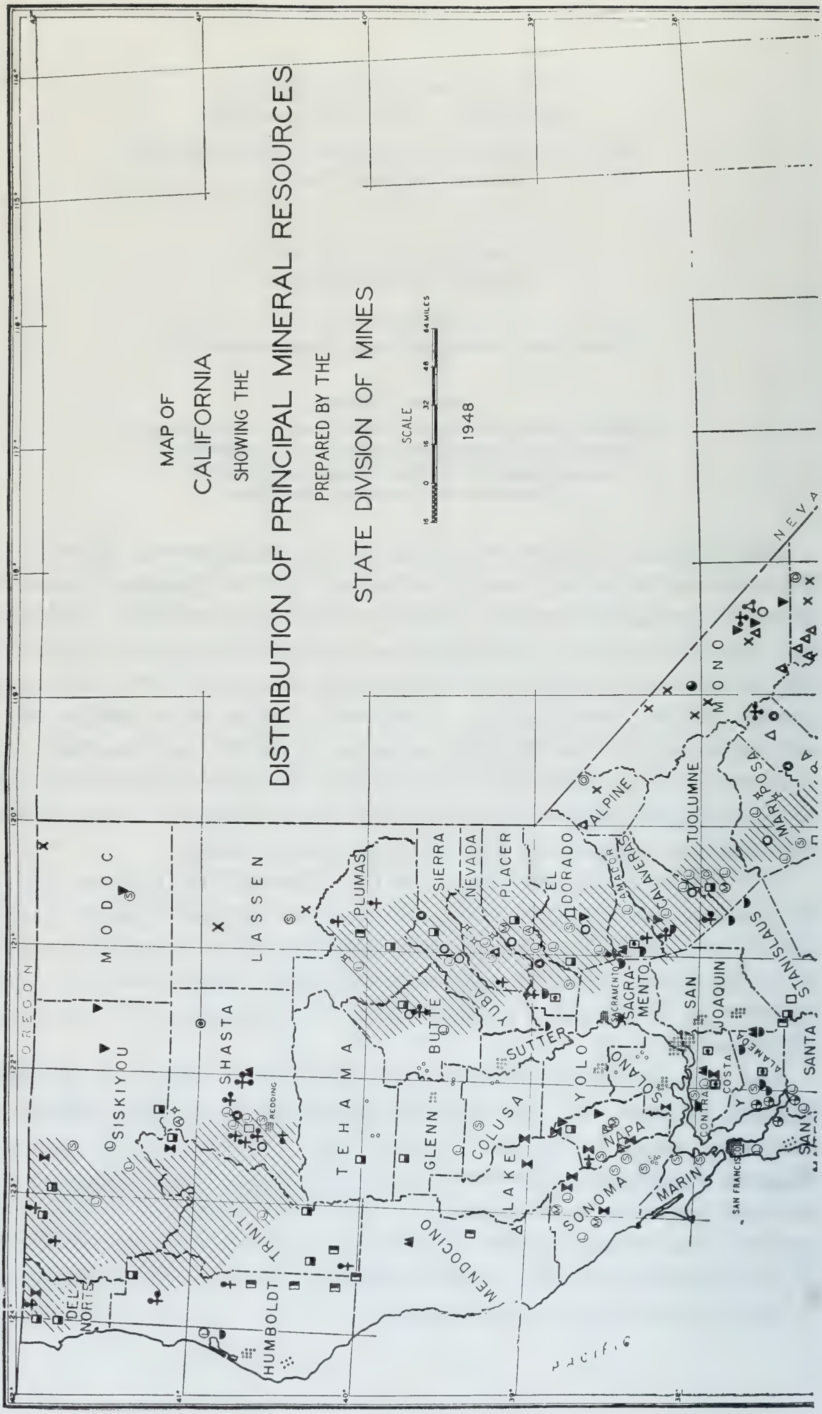
MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
NEVADA
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
REDDING
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
PLACER
YUBA
SUTTER
COLUSA
LAKE
YOLO
EL DORADO
ALPINE
AMADOR
CALAVERAS
TUOLUMNE
MONO
MARIPOSA
SACRAMENTO
SACRA-MENTO
SAN JOAQUIN
STANISLAUS
SONOMA
NAPA
SOLANO
MARIN
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
SAN
SANTA
PACIFIC

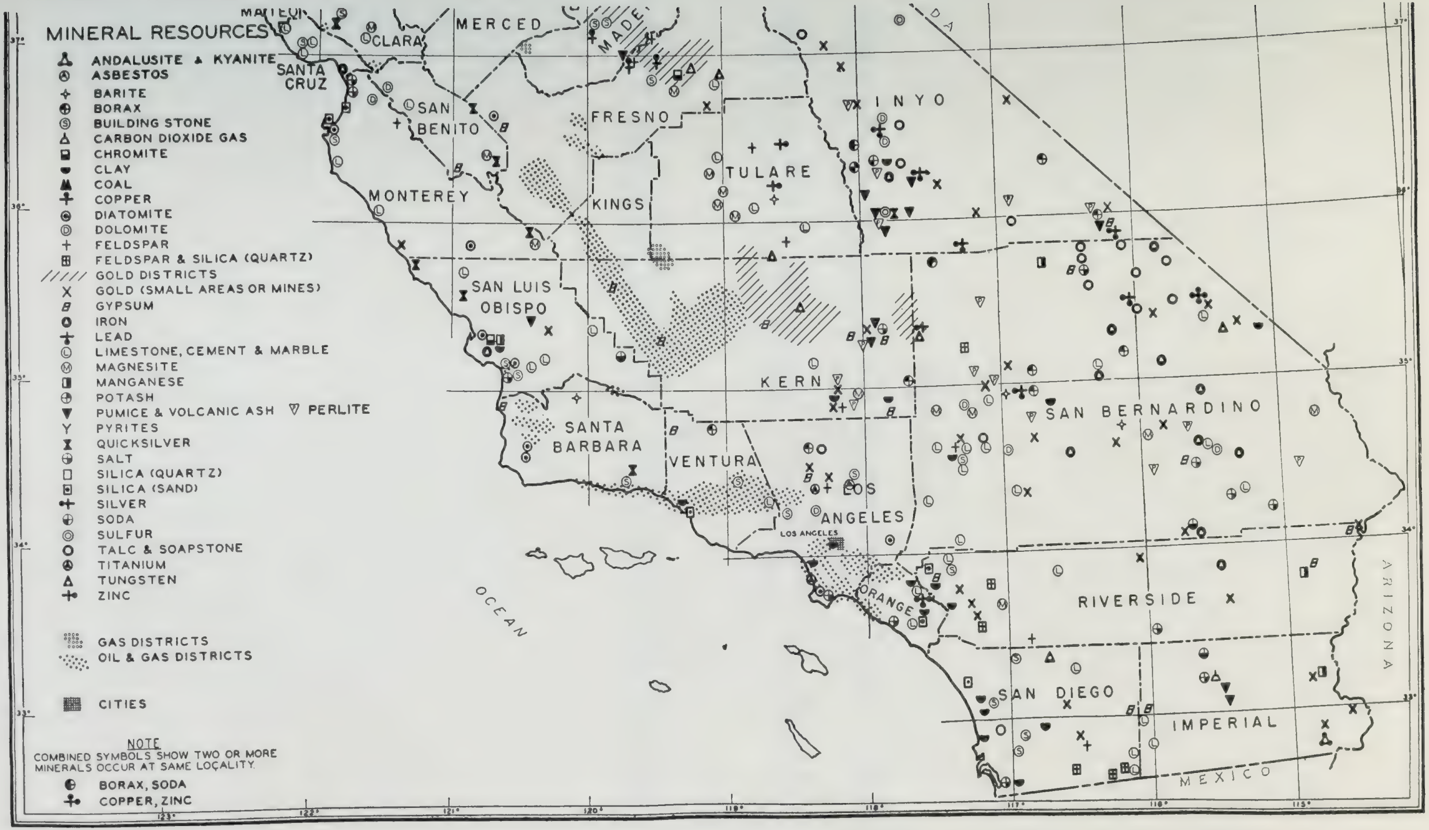
MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MERCED
CLARA
SANTA CRUZ
SAN BENITO
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN

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Plate 2. Geologic map of Santa Clara County, California, showing mines and mineral deposits ---------- In pocket

NINETEENTH CENTURY MINES AND MINERAL SPRING RESORTS OF LAKE COUNTY, CALIFORNIA

By Frederick J. Simoons *

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ABSTRACT

Lake County, isolated in the Coast Ranges 80 miles north of San Francisco Bay, experienced a local mining boom in the nineteenth century. It was there that the first borax produced in the United States was extracted (1864), as well as the first California sulphur (1865), and a tenth of California's quicksilver. Moreover, the many hot and cold mineral springs in Lake County's chamise and pine covered hills soon attracted thousands of eager health seekers who willingly braved the rough, dusty stagecoach ride to the many resorts that sprang up. By the eighties Lake County resorts had developed into considerable establishments renowned throughout northern California for the reputed effectiveness of their waters. At the close of the century Lake County was a thriving resort area though mining, after disheartening setbacks, was at a low ebb.

The present century has brought temporary, wartime recoveries in mining, but a continued decline in the popularity of mineral spring resorts. Most of the famous, old resorts have failed, though a few remain today to supplement the new, week-end-type resorts in the pine woods and along Clear Lake.

Early mining and resort activities had a salutary effect on the local economy, providing the pioneer farmers with a local market for their produce, livestock, and wood that better enabled them to survive until large scale commercial farming was made possible by the improvement of transportation to out-of-county markets.

* Condensation of part of thesis, Department of Geography, University of California, Berkeley, California. Manuscript submitted for publication January, 1953.

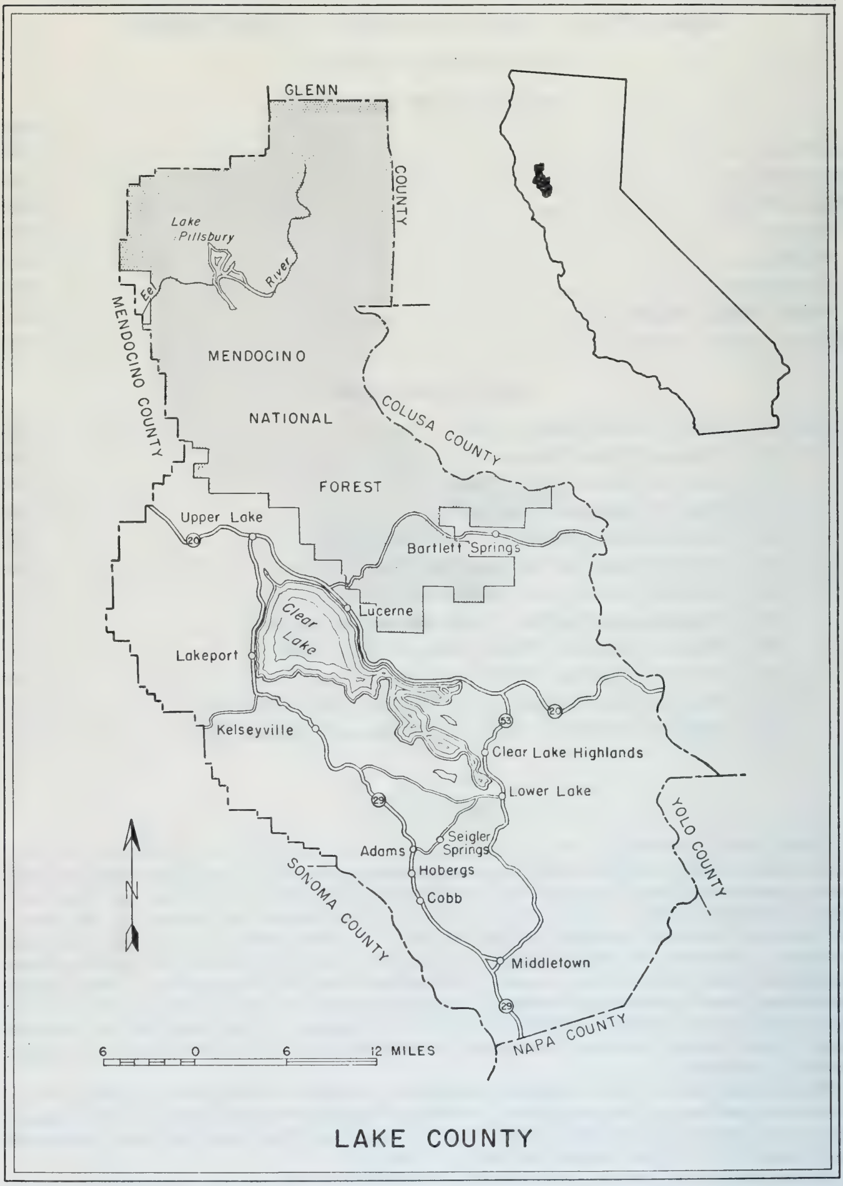

FIGURE 1. Index map of Lake County. Insert shows location of Lake County in California.

INTRODUCTION

Lake County is a thinly settled region (area 1,256 square miles, 1950 population 11,000) only 80 miles north of the highly urbanized San Francisco Bay area. It is centered on a complex structural depression in the Coast Ranges, which is occupied in part by 18-mile-long Clear Lake (elevation 1,325 feet), largest freshwater lake entirely within California.

The southern two-thirds of Lake County constitutes a distinct physiographic unit, hemmed in by northwest-trending ridges covered with chaparral and pine woods that rise 1,500 feet or more above the lakeside valleys, and drained largely by two streams, Cache Creek and Putah Creek, which flow southeastward to the Sacramento River. North of Clear Lake, where ridges reach 5,000 feet in elevation, is a rough, virtually unoccupied section included in the Mendocino National Forest, that is drained by streams flowing northwestward into the Eel River.

Besides the high, parallel ridges trending northwest-southeast, three other principal types of landforms can be distinguished in Lake County: (1) volcanic highlands, found southwest of Clear Lake, (2) hills, and (3) scattered valleys.

The climate of the Clear Lake country is characterized by hot, dry summers and mild, rainy winters. Average monthly summer temperatures are between 70° and 75°F, with maximum temperatures of more than 100°F occurring in late July or early August. Average January temperature is between 40° and 45°F and it never falls below 0°F in the valleys. Valley areas throughout the highland have average precipitation ranging from 22 to 50 inches annually, though on the ridges nearby average annual precipitation reaches as high as 78 inches. About 90 percent of the yearly precipitation falls in the period from October to April, most of it in the form of rain. The snow that falls in the valleys melts within a few days, while higher ridges in winter often remain blanketed for several weeks. The high northern mountains have a much more severe winter than the southern sections; snow a few feet deep on the higher slopes makes transportation difficult. Summer months are characterized by clear, hot, sunny days and cool evenings.

Lake County valleys are grass-covered with oaks scattered over the valley floors, and with a woodland-grass association bordering it upslope. Chaparral is found still higher and in turn gives way to conifers on the high mountains. In 1948 it was estimated that almost one-third of the land area of Lake County was covered by chaparral, while 28 percent was in hardwood woodland or woodland grass, and 27 percent was in commercial forest or noncommercial coniferous woodland. Grass areas and cultivated, urban, and industrial areas together totaled only 10 percent.

Though local residents fought vigorously for the construction of a railroad to Clear Lake, none was ever built. Today the important agricultural valleys bordering the lake are tied to each other and to Ukiah and Hopland on the railroad along the Russian River to the west by modern, paved highways. Similar highways connect the lake towns with Williams in the Sacramento Valley and with Middletown and the Napa Valley railhead at Calistoga to the south. Graded dirt or gravelled roads provide the only transportation in the northern mountains, the

southeastern section of the county, and the back areas beyond the reach of the paved highways.

The important economic activities of Lake County include ranching (cattle and sheep) and orchard culture (pears, prunes, and walnuts)—both of which are confined largely to the valleys and lower slopes—resort activities, and lumbering in the northern mountains. Lake County accounts for a tenth of California's pear production. The delicious, high-quality, mountain Bartletts that are the principal variety grown are sold fresh on the Eastern and California markets where they command premium prices. Increasing amounts of pears are being sold to canners outside the county, while the practice of drying the fruit locally has declined. Walnut plantings have been expanded rapidly in recent years, replacing many of the older, less profitable prune orchards in the valleys and spreading into the hill areas. Almonds are a minor commercial crop. Grapes are neglected and at the present time there is not a single winery in the Clear Lake country. The area thus contrasts with neighboring Napa and Sonoma Counties which have achieved nationwide renown for their fine dry wines. Beans are grown and canned on reclaimed land near Upper Lake. Of the 150,000 case output, 60 percent are limas and the rest are string beans. Hops are raised in one large hop yard in Scott Valley. Dairying and chicken ranching are practiced to some extent. Lumbering operations in the Mendocino National Forest, which occupies the northern third of the county, have tripled since the beginning of the second world war; in 1946 eleven million board feet were cut, almost entirely of Ponderosa pine and Douglas fir. Small weekend-type resorts are scattered along the shores of Clear Lake and the Blue Lakes as well as among the cool pine woods of the volcanic mountains southwest of the lake. Other sections of the county are visited in season by campers and hunters.

The summer visitor to Clear Lake today is struck by the contrasts among the hot, dry, chaparral-covered hills, the valleys with their sear, yellow grasses and green orchard trees hanging heavy with fruit, the cool, pine-forested mountains, and the fresh, still waters of resort-bordered Clear Lake. Nowhere away from the resorts does one find the rude, bustling atmosphere that is so typical of the expanding communities of the Central Valley of California. Instead, the Lake County valleys have a quiet aspect, their towns such as Lakeport, Upper Lake, Kelseyville, Lower Lake, and Middletown retaining the appearance of comfortable gathering places of the rural folk.

Geology. Geologic studies in Lake County have been concerned principally with the quicksilver mining areas of the south and the regions of recent volcanism bordering Clear Lake. Sedimentary and volcanic rocks of the Franciscan group, the "basement" formation of the Coast Ranges, cover more than half of the mapped areas of Lake County and underlie all of the county. These rocks were intruded south of Clear Lake, by northwest-trending bodies of serpentine (Averill, 1947, p. 17). The Franciscan group is overlain in the areas bordering Clear Lake by Eocene and Pliocene sedimentary formations, and, in some locations, by Quaternary alluvium or terrace deposits. Volcanic rocks of Quaternary age add further to the complexity of the lake borderland. These rocks are primarily extrusive and include both flows and pyroclastic materials. Patches of Tertiary volcanic rocks occur throughout southern Lake County.

In general terms, the structure of the upland consists of broad, northwest-trending folds, displaced by steeply dipping faults which trend nearly parallel to the fold axes (Brice, 1953). The larger topographic features of the Clear Lake upland appear to be structurally controlled by this folding and faulting. Locally, however, the effect of lithology is pronounced and is often more important than structure in determining topography (Borglin, 1950, p. 8).

Geology, Topography, and Human Occupancy. Topography and bedrock have placed important limits on human occupancy in the Clear Lake area. The majority of the land is rough, hilly, or mountainous and unsuitable for agriculture. The folded ridges, the volcanic upland, and the dissected hill country all present this handicap.

Even those areas flat enough for agricultural use offer other discouraging deficiencies. Residual soils are generally poor. Soils developed from the widespread Franciscan group rocks and the Pliocene sedimentary formations are generally poor, clay loam soils containing appreciable sand. They become hard and baked on drying and have poor moisture-holding capacities. Crop yields on these soils are low and thus they are little cultivated (Carpenter et al., 1927, pp. 30-31). Serpentine, which crops out in extensive elongated bodies in southern Lake County weathers into virtually worthless soils. These serpentine soils have been the subject of considerable discussion and experimentation in recent years, but no crops have been found that do well on them. Sections of Coyote Valley and Long Valley (Middletown) in the southwestern corner of the county have soils derived in part from serpentine. These sections are distinctly marginal for farming and attempts to plant orchards on them have met with little success. The volcanic soils, on the other hand, are of fair to good agricultural value. These clay loam and gravelly clay loam soils are cultivated more than any other residual soils. It is the alluvial soils, however, that are most attractive for agriculture; and the valleys in which they are found, favored also by slope and available water supply, are the primary agricultural areas.

Besides its importance for agriculture, through influence on soil, bedrock has been of significance for mining and early resort development. Cinnabar, the chief quicksilver ore mineral, occurs most often in Lake County in fractured rocks of the Franciscan group, frequently at or near their contact with serpentine, and often in silicified alteration products of the serpentine. The cinnabar has been deposited by hot solutions connected with the declining Quaternary volcanic action. The numerous hot mineral springs, which were especially attractive to health-seekers and which resulted in the location of the most important concentration of resorts in the volcanic mountains southwest of Clear Lake, are evidence of this late stage of volcanism.

Early History of Settlement. Throughout history the Clear Lake country has lain somewhat aside from the main currents of settlement and commerce. In the Spanish period it was on the northern fringe of mission influence and its numerous aboriginal peoples were left unmolested to pursue their primordial activities of hunting, gathering, and fishing. The tule-bordered, 18-mile-long lake was the focus of Indian subsistence activities. The abundant fish population of Clear Lake was supplemented seasonally by tens of thousands of waterfowl and by

runs of fish up adjacent streams, creating a bounty shared by bands of natives from nearby areas. The grassy alluvial valleys adjoining the lake provided abundant game, while acorns from the huge oaks which dotted the valley floors further contributed to what must have been, by California Indian standards, an ample living.

Russian fur traders from the coastal settlement at Fort Ross, 60 miles to the southwest, probably never reached Clear Lake, but enterprising American trappers arrived as early as 1833, building small cabins and sometimes remaining one or more seasons. Mexican and American ranchers, who had obtained Mexican land grants, were driving herds of cattle and horses over the Mayacmas Mountains in the eighteen thirties and forties from the newly settled, alluvial valleys of Napa and the Russian River, but it was not until the mid-fifties, when the gold fever had begun to subside, that permanent agricultural settlers entered the region. These self-reliant pioneers, most of whom were from mid-western and southeastern states, occupied almost all of the good valley lands within a dozen years and developed an occupancy pattern of dispersed farms each with its small, family orchard and garden, adjacent fields of wheat and barley, with cattle and sheep grazing on the bottom lands and hills, and hogs foraging wherever food could be found. The narrow, winding mountain roads connecting the Clear Lake country with the outside world provided tenuous and costly transportation and settlers' subsistence activities were usually supplemented only by a small cash income derived from the sale of livestock, grain, or produce.

MINING HISTORY

In its pioneer period Lake County was noted not for its agriculture, but for its mines and mineral springs, the most important of which were in the southern half of the county. The Lake County quicksilver mines first came into production in 1870 and throughout this era quicksilver mining continued to have an important influence on the economy of the county. It was in the mining of borax and sulphur, however, that Lake County attracted most attention in its earliest mining days. Here, in 1864, the United States' first borax was manufactured (Bailey, 1902, p. 33), and a year later California's first sulphur was extracted (Jenkins, 1950, p. 274).

Borax

In 1856 Dr. John A. Veatch, after prospecting throughout the mountains of northwestern California, discovered just east of Clear Lake a small lake of interior drainage, subsequently called Borax Lake, whose waters were highly charged with biborate of soda and whose bed contained numerous borax crystals. It was not until 1864, however, that these deposits were worked commercially. The twelve tons of borax produced in that year by the California Borax Company was the first produced "in the American continent" (Bailey, 1902, p. 33).

The methods of extracting borax practiced in Lake County were similar to those developed a century before at the borax lakes of Tibet and involved either collection of the available large crystals or evaporation and crystallization of water (Hanks, 1883, p. 7). At Borax Lake the large crystals, some of which weighed as much as several ounces, were concentrated in the first 5 feet of the lake mud. Beneath this depth no large crystals were found, although the lower mud was

saturated with borax and other salts (Hanks, 1883, p. 21). These crystals provided the most accessible source of borax and for 2 years placer techniques were followed in separating them from the lake mud.

Mud was dug from the lake bottom by means of small iron cofferdams, 4 feet square and 4 feet deep (Hanks, 1883, p. 21). The mud was carried ashore by boat and then washed in crude sluices, the heavier borax crystals being caught in the riffles and removed (Bailey, 1902, p. 51). Crystals in Borax Lake were so abundant that as much as nine hundred pounds of them were removed from one cofferdam (Hanks, 1883, p. 21).

After 2 years of the operations described above the company had nearly exhausted the layer of large crystals and had to devise other methods of extracting borax. Extensive works were constructed with the intention of obtaining borax from minute particles in the lake mud not recoverable by using placer techniques (Goodyear, 1890, p. 237). The new method of operation involved boiling the lake mud in water in a large, steam-heated boiler until the minute borax crystals were completely dissolved. Then the mixture was drawn off into round vats. Threads were suspended in the liquid and the borax crystalized. In the fall of 1866, these operations were carried on by 130 laborers, most of them Chinese, but shortly thereafter a steam dredge was constructed, replacing most of this manual labor (Carpenter and Millberry, 1914, p. 318).

The method of boiling the lake-bottom mud and recrystallizing borax did not prove to be so profitable as the earlier practice of removing the crystals directly from the mud (Goodyear, 1890, p. 237). Two or three wells were bored in the bottom of the lake in the hope of finding stronger borax solutions and replenishing the borax (Anderson, 1936, p. 655).[1] Unfortunately, the lake was flooded as a result of this well-digging by an uncontrollable artesian flow which flooded the furnaces on the lake shore. The works at Borax Lake were abandoned in 1868, and have never reopened.

Less than a year following the failure of the Borax Lake works, borax extraction was started commercially at Lake Hachinhama, later known as Little Borax Lake, located on the south shores of Clear Lake at the base of Mount Konocti.[2] This small lake occupies a shallow crater formed by a recent phreatic explosion (Anderson, 1936, p. 658). Becker (1888, p. 245) believed that the borax in the lake had been deposited by hot springs that once flowed into it. No crystals were found in the

[1] According to Anderson, the source of the borax "appears to have been from the northeastern edge of the obsidian, at Little Sulphur Bank, where there is some indication of recent solfataric activity. . . . The surface slopes gently to the north, so that any active discharge from the springs in the past would find its way to the basin, where it would be concentrated."

Becker (1888, p. 266) believed that a hole bored into the Little Sulphur Bank might "bring about a renewed flow of dilute solution of borax, which by concentration under the hot summer sun in Borax Lake would yield the salt in profitable quantities."

Bailey (1902, p. 33) states that operations stopped at Borax Lake when the artesian flow "diluted the waters of the lake beyond the profit point." Nevertheless, I could find no early reference to the extraction of borax directly from the lake waters at Borax Lake and it seems likely that the works were abandoned simply because of the flooding of the furnaces and the difficulty of operating in the higher water.

[2] Bailey (1902, p. 39) and Averill (1947, p. 19) imply that there was no borax produced in Lake County in the years 1869, 1870, and 1871 and that Little Borax Lake was worked only in 1872 when it produced 140 tons. However, statements in the *Lower Lake Bulletin* and *Lakeport Avalanche* indicate that borax production was already under way in October 1869, and was continued intermittently during the following 3 years.

FIGURE 2. Borax Lake in late summer. The furnaces were located on the eastern shore, on the left side of the photograph.

mud here (Bailey, 1902, p. 52), and borax was taken only by the evaporation of the lake water.

The refined borax was shipped to San Francisco from Borax Lake by wagon (*Napa County Reporter*, Oct. 27, 1866, p. 1). Little Borax Lake, when first developed in 1869, sent the crude product to San Francisco where the refining process was carried on, but later refining was conducted at the lake (*Lower Lake Bulletin*, Nov. 20, 1869, p. 2).

Before the development of the Lake County deposits, all borax consumed in the United States had been imported.

Borax was used in the mint for assaying purposes, for welding and working iron, glazing pottery, in medicine, and for cleaning. Borax Lake supplies were sufficient to meet the small United States demand for borax and to compete to a small extent with the British monopoly in the foreign market. Although the value of American imports of borax from 1855 to 1863 was between $143,000 and $217,000, it fell suddenly

*Lake County borax production.**

Place	Year	Production (tons)	Value per ton	Total value
Borax Lake	1864	12	$780	$9,478
Borax Lake	1865	125	750	94,099
Borax Lake	1866	201	660	132,538
Borax Lake	1867	220	710	156,137
Borax Lake	1868	32	666	22,384
Hachinhama	1869	?	704	?
Hachinhama	1870	?	604	?
Hachinhama	1871	?	625	?
Hachinhama	1872	140	640	89,600

* After Bailey, 1902, p. 39.

to $8,900 in 1864, when operations began at Borax Lake (Hanks, 1883, p. 21). During the days of Lake County production the price of borax was always high, varying from 39 cents a pound for the refined product in 1864 to 32 cents in 1872.

The collapse of borax mining in the Clear Lake upland was sudden and complete. Borax had been discovered at Searles Lake in San Bernardino County in 1863, before extraction began in Lake County (Bailey, 1902, p. 37). Other finds in Nevada and southern and eastern California followed this one, but it was not until 1870 that shipments of this product began to arrive in San Francisco from Nevada (*Clear Lake Courier,* Dec. 31, 1870) and construction of a refinery was started at North Beach.[3] Receipts of borax gradually increased until in 1873, the cheap, abundant borax from Searles Lake flooded the market with record supplies and drove the pioneer Lake County producers from the scene (Bailey, 1902, p. 37).

[3] It is interesting to note that in 1873 "large quantities" of Nevada borax were hauled into Lake County to be purified. (*Pacific Rural Press,* May 3, 1873, p. 278.)

FIGURE 3. Little Borax Lake. Behind are lower slopes of Mt. Konocti and Clear Lake.

FIGURE 4. Sulphur Bank mine, showing the extensive open pits and the remaining mine buildings. The small island on the extreme right in Clear Lake is Rattlesnake Island on which the Indian village of Elem was located.

Sulphur

In 1865 the pioneer California Borax Company produced the first sulphur mined in the state, working solfataric deposits at Sulphur Bank only a mile north of Borax Lake (Jenkins, 1950, p. 274). The extraction of sulphur ore was from surface cuts made with little regard to system (Becker, 1888, p. 253). Strong sulphurous fumes at first prevented penetration more than a few feet below the crust. The crude sulphur was thrown on a car which ran on tracks to the refinery, where it was placed in retorts, heated, drawn off into boxes in a liquid state, cooled and shipped (*Lower Lake Bulletin,* June 17, 1871, p. 3). As the cuts deepened, cinnabar in increasing quantities was found in the ore, darkening the color of the sulphur and increasing the cost of the refining process (Nichols, 1948, p. 174). Quicksilver was not reclaimed as a by-product, but it seriously affected the operations of the retorts, although it did not prevent the separation of the sulphur and quicksilver (*Lower Lake Bulletin,* June 17, 1871, p. 3).

*Sulphur production of Lake County.**

Year	Pounds	Value
1865	214,650	$8,030
1866	675,963	21,970
1867	487,603	13,420
1868	503,481	10,080
1869-1871	?	?
Totals	1,881,697	$53,500

*Averill, 1947, p. 19.

Increasing costs, coupled with falling prices (Everhart, 1946, p. 129), and the expense of transporting sulphur to distant markets (*Lower Lake Bulletin,* Oct. 23, 1869, p. 3) led to a cessation of activities about 1871.[4] Total sulphur production from the mine amounts to about two million pounds. This marked the end of California sulphur output until 1923-24, when a Kern County mine operated briefly (Jenkins, 1950, p. 274).

Quicksilver

Though dwarfed by comparison with the New Almaden and New Idria workings of Santa Clara County and San Benito County respectively, which have accounted for three-fifths of the state's total quicksilver output, the mines of Lake County have nevertheless contributed significant amounts of quicksilver. Together they have accounted for more than 10 percent of the state's total output and, with the neighboring mines of Napa and Colusa Counties, contributed 25 percent of California's total production.

Most of the quicksilver ores of Lake County occur as irregular bodies along zones of fracturing or faulting in serpentine or in the Franciscan group rocks with which serpentine is associated; some quicksilver ore is also found in the Tertiary-Quaternary volcanic rocks. The quicksilver is believed to have been deposited from hot mineralized solutions, vapors, and emanations derived from the Quaternary volcanic activity (Nichols, 1948, p. 176).

Within the Clear Lake area are four quicksilver districts (1) Mayacmas, covering southwestern Lake County and parts of neighboring Sonoma and Napa Counties, (2) Knoxville, at the meeting of Yolo, Napa, and Lake Counties, though principally in Napa County, (3) Sulphur Creek, almost entirely within Colusa County, but with a corner included in Lake County, and (4) Clear Lake, which, since it includes only the Sulphur Bank mine and one small prospect on Mt. Konocti, cannot be considered a district in the same sense as the others.

The early use of quicksilver (mercury) was in the recovery of gold and silver by amalgamation, but by 1915 the cyanide process of gold and silver recovery materially reduced the demand for quicksilver. By this time, the manufacture of fulminate for explosive caps was a more important use of mercury than amalgamation. In these later times, mercury found increasing uses, too, in the manufacture of chemicals as well as in industrial and scientific instruments.

Before the development of California's quicksilver reserves, United States demands were supplied chiefly from Spain and Austria. The ores mined in Europe were rich, those of Almaden, Spain, yielding as much as 7 percent mercury (U. S. Tariff Comm., 1920, p. 267), while California's ores averaged only 0.5 percent metal. Thus, California mines were at a tremendous disadvantage, particularly when compared with those of Almaden. No metallurgical advances could conceivably offset the Spanish advantages of high grade ores.[5] California developed its

[4] Averill (1947, p. 34) states that the Sulphur Bank has not been worked for sulphur since 1868, and in this he follows earlier reports. However, the *Lower Lake Bulletin* frequently refers to operations at Sulphur Bank until August 1871, when a "temporary" suspension of operations is mentioned.

[5] In 1918 it was estimated that the cost of producing quicksilver averaged between $70 and $75 a flask in California. At the same time the cost at Almaden was $33 a flask. (U. S. Tariff Comm., 1920, p. 267.)

*Lake County quicksilver production, 1873-1950.**

Year	Flasks	Value	Year	Flasks	Value
1873	880	$70,790	1913	395	$15,891
74	1,695	178,280	14	331	16,236
75	8,821	743,287	15	492	41,660
76	14,199	624,756	16	1,139	106,496
77	18,100	675,130	17	1,067	107,071
78	14,428	474,681	18	1,540	172,173
79	15,582	309,303	19	229	20,604
1880	17,148	531,588	1920	385	24,314
81	17,393	518,833	21	22	880
82	10,193	287,748	22	38	2,000
83	6,481	186,329	23	17	1,050
84	4,182	127,551	24	------	------
85	4,765	146,524	25	------	------
86	3,498	124,179	26	86	7,778
87	4,307	182,509	27	245	29,234
88	6,636	282,030	28	1,206	145,718
89	4,713	212,085	29	1,697	203,247
1890	4,232	222,180	1930	1,760	195,710
91	4,975	225,119	31	3,046	251,879
92	11,140	453,509	32	1,038	57,850
93	9,731	357,614	33	1,610	90,592
94	12,471	382,954	34	3,497	221,837
95	12,856	465,074	35	4,097	285,426
96	6,307	232,484	36	3,795	292,571
97	3,585	134,546	37	4,012	341,444
98	1,729	64,746	38	3,718	265,430
99	2,954	128,179	39	4,155	416,150
1900	3,165	127,345	1940	4,966	845,592
01	4,395	211,324	41	6,053	1,045,726
02	3,611	161,568	42	4,216	792,438
03	2,595	106,397	43	4,206	774,813
04	2,854	109,719	44	3,781	430,317
05	1,462	51,937	45	1,448	180,776
06	1,066	38,909	46	[1]	[1]
07	802	30,604	47	356	[2]
08	1,300	54,951	48	[2]	[2]
09	1,075	56,277	49	0	0
1910	1,048	47,422	1950	[2]	[2]
11	899	41,363			
12	209	8,786	Totals	312,125	$16,771,513

* From Averill, op. cit., pp. 11-12.
[1] California Div. Mines not at liberty to publish figures.
[2] U. S. Bureau of Mines not at liberty to publish figures.

mercury mines at a time of high prices and with tariff protection. Even so, the cheap Spanish product, which was for many years controlled by British monopolists, periodically flooded the American market, causing tremendous price fluctuations which drove American producers out of business. Quicksilver mining was thus tied to world conditions more than any other important economic activity in Lake County.

Although some quicksilver was taken from the New Almaden deposits as early as 1846, California experienced its first quicksilver boom only after the gold strikes of the Sierra Nevada created a huge new demand for quicksilver. Prospecting and development of quicksilver deposits in the Clear Lake upland, however, was delayed until the early sixties and it was not until 1870 that mines within Lake County began to produce (Bradley, 1915, p. 52).

For the first few years the mercury output of Lake County was negligible, but in 1873, when the American (Helen), Sulphur Bank, and Great Western mines were opened, production jumped rapidly. The seventies were the most active mining period in Lake County's

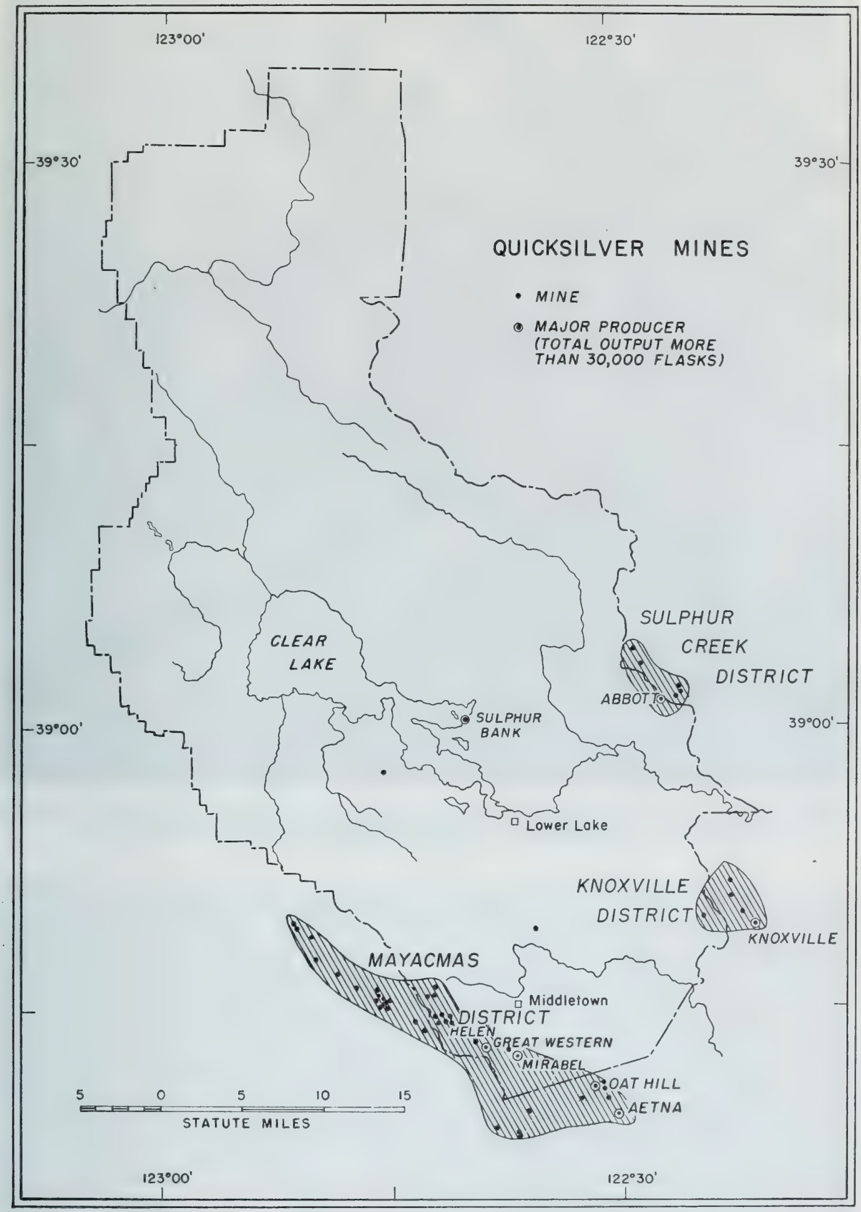

FIGURE 5. Quicksilver mines in Lake County.

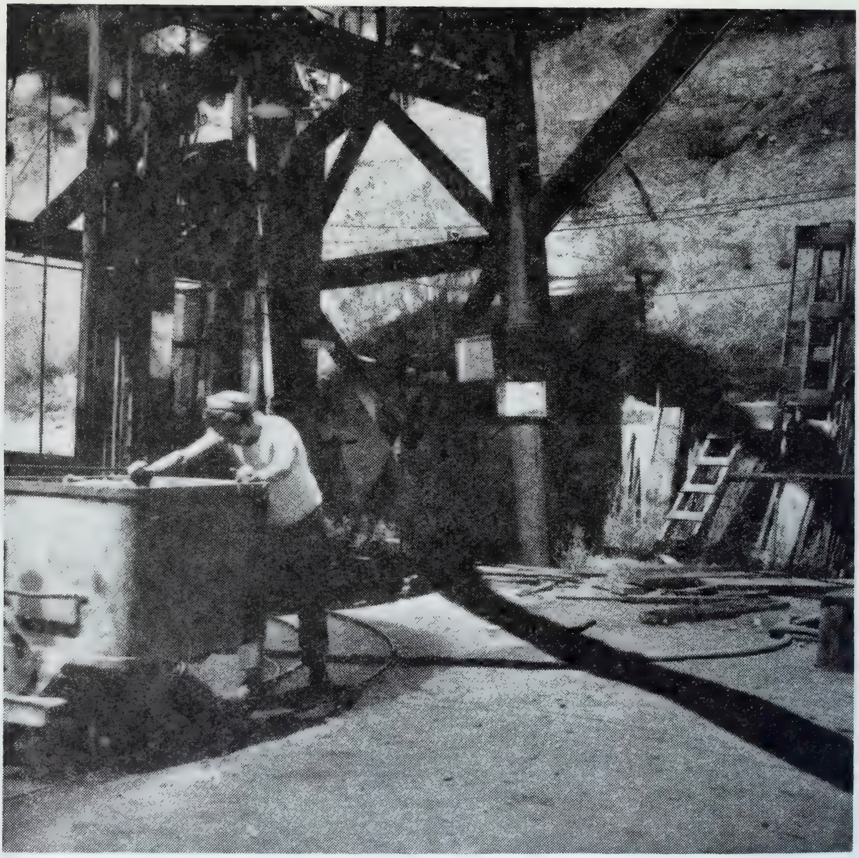

FIGURE 6. Hand car being pushed from the shaft of the Abbott mine. Today ore is removed by blasting and pick-and-shovel methods from the 200-foot level.

history. More than 18,000 flasks of mercury were produced in 1877, the peak year. The eighties saw a rapid decline in production in Lake County, as elsewhere in California,[6] but there was a temporary revival from 1891 to 1896. Subsequently, however, production fell off slowly until 1912 when only 200 flasks were produced. Although revivals of quicksilver mining have taken place during both the first and second world wars, production has never approached that attained during the peak period of the last century. Today, while many of the old California quicksilver mines are being reopened under the stimulus of the Government stockpiling program, in mid-1952 in Lake County only the Abbott mine was extracting appreciable amounts of metal and even there, the old mine village is occupied by only a half dozen families.

At an early day numerous small mines were established throughout the southern hills, especially in the Mayacmas district. Many of these mines produced a total of less than a hundred flasks of mercury in their

[6] In 1883, eight California quicksilver mines petitioned the United States Congress for a tariff on foreign mercury imports. They complained that the placing of quicksilver on the free list so sharpened competition with European producers that in a few years' time only eight of 30 mines in the state were able to continue operations. (Mandeville, 1883.)

FIGURE 7. Abbott mine buildings. Ore is dumped from the hand car down a chute at the top of the trestle. The waste heap, the top of which may be seen at the left of the picture, extends far down the hillside.

productive years. When prices slumped, or when the ore body played out, these mines were usually abandoned, the owners salvaging what equipment they could. The major effect that the small, marginal producers had in Lake County was to instill in the local people some of the characteristic strike-it-rich philosophy of the prospector. Today only collapsed or flooded adits and shafts, together with ore dumps, testify to this brief episode in the county's history. The polyglot names of the mines are recorded in contemporary accounts, but little specific information of their activities is to be found in any of the written records.

Several quicksilver ore bodies yielded satisfactorily and some have been exploited sporadically until recent times. All of these deposits were worked by the mid-1870's and no recent discoveries compare with them in quality and quantity of ore. The Oat Hill mine in the Napa County section of the Mayacmas district proved to be the most important producer in the area. By 1946, its total mercury production had reached about 160,000 flasks, which was exceeded in the United States only by New Almaden and New Idria mines (Yates and Hilpert, 1946, p. 261). The Knoxville (Napa County), Sulphur Bank, and the Great Western mines were of the next rank of importance. All of these mines

refined over 100,000 flasks of mercury, placing them among the top several quicksilver producers of the nation. The Aetna (Napa County) and the Mirabel mines have produced somewhat less, each with between 50,000 and 70,000 flasks of mercury to its credit. The Abbott mine, most productive mine of the Sulphur Creek district, has produced between 30,000 and 40,000 flasks. Together these large mines have probably accounted for 90 percent of the total quicksilver production in their respective districts, none of the other mines having a cumulative production figure of as much as 20,000 flasks of mercury.

Before mercury mines could produce ore, it was usually necessary to conduct expensive exploratory work, as well as to sink shafts, drive adits and to install reduction furnaces. Separation of mercury from ore was accomplished essentially in this manner: ore was placed in a wood-heated furnace, mercury vapor was driven off and then condensed by cooling, and run into 4-pound iron flasks which when filled weighed $76\frac{1}{2}$ pounds.[7]

From the mines the flasks were hauled by wagon to the nearest railroad, thence to San Francisco, from which mercury was shipped by rail to the western gold and silver mining areas, or by ship to the mining districts of Mexico, China, Australia, New Zealand, and South America (Mandeville, 1883, p. 7).

Capital for large-scale mining operations in Lake County was derived largely from San Francisco, although English capitalists controlled a few of the mines. Handicapped by low-grade ores, Lake County mine owners made every effort at minimizing expenses. Thus they demanded cheap, efficient labor which was scarce in this pioneer country. It was common for Lake County farmers to work at surface jobs at the mercury mines in winter, but they provided no large and willing local labor supply and the mines brought in help from outside the area. Usually itinerant American "tramp miners" formed a cadre highly valued for their experience in working different types of deposits. Many foreign mine laborers, especially Chinese, were also hired. The Sulphur Bank, Great Western, Mirabel, and Oat Hill mines, among others, used large amounts of oriental labor. The Sulphur Bank had a large group of Austrians at one time, the Knoxville mine in 1870 had mostly Irish, the Helen mine used Italians, and the Mirabel once had many Cornishmen who left a strong memory of their fine group singing. Indians did not work in the mines.

Flimsy "Chinatowns" which were established near the mines employing Chinese help, were one of the most colorful elements in the early mining days. These settlements were noisy and crowded, with frequent fights, although strong tong organizations usually provided inter-group order. Of all the mine help, the Chinese provided the cheapest, most flexible labor supply, often undertaking work refused by whites. Despite this, full use of the potential Chinese labor force was prevented by occasional local anti-Chinese violence as well as by discriminatory state legislation. By the end of the nineteenth century, immigration restrictions had dried up the source of cheap oriental labor.

The mine market encouraged a brisk trade in food supplies as well as in wood and timber. The southern region of the county was most

[7] Before June, 1904, a flask of quicksilver legally contained $76\frac{1}{2}$ pounds, but subsequently only 75 pounds.

benefited, because the mines were located there, but lake boats provided cheap transportation and enabled the northern lake areas to share in the trade too, especially with the Sulphur Bank which was most accessible. Much wood was used in mine reduction furnaces and contracts were made with ranchers for wood. Ranchers carried on cutting activities in winter, often with the help of Indians and on rare occasions with Chinese help. The ranchers in the valleys northwest of Clear Lake delivered their wood to piers where lake boats picked it up. Oak of various kinds was generally used as fuel, but pine and sometimes even manzanita were burned. Lumber and mine timber were usually supplied by sawmills, owned either by private individuals or mine companies. Douglas fir was used for timbering.

Other Mining Activities

In its early days Lake County was thoroughly prospected for workable deposits of minerals other than quicksilver and at various times copper, gold, and silver discoveries were reported. Despite occasional flurries of excitement following the location of new prospects, only the quicksilver mines continued to operate, providing an important, although sporadic, cash income to local residents. It was only much later, during the two world wars of the twentieth century, that small amounts of chromite and manganese ore were mined profitably. In 1951 reports that two development companies were searching for iron ore in Indian Valley showed that even today the hope of finding major new mineral deposits has not been abandoned.

MINERAL SPRINGS RESORTS

The Mineral Health Complex in California. The custom of vacationing at mineral health centers, carried to California by immigrants from the East, found early expression in the establishment of scores of mineral spring resorts. The Clear Lake area was especially favored, for it possessed many and varied springs, especially in the areas affected by recent volcanism.

Location of Resorts. It was in the volcanic upland, including the Cobb, Boggs, and Harbin Mountain sections, which possessed all of the hot springs, that the earliest and most important resort development took place. Two other concentrations of resorts were established, one east of Clear Lake comprising Bartlett, Newman, Allen, and Hough Springs, and another west of Upper Lake, including Witter and Saratoga Springs. The only successful resort developed outside of these three clusters was Highland Springs in the hills southwest of Big Valley. Despite the great popularity of individual resorts in other sections, no area of Lake County was able to rival the volcanic upland in variety of mineral waters and numbers of resorts.

In the early days Clear Lake itself was not important for recreation, perhaps in part because of the thick stands of tule growing along its shores. Resorts were located in the mountains or hills, often in spots which had no recreational advantage other than a highly valued medicinal spring. The only apparent exceptions to this generalization were the Soda Bay Hotel, situated on Clear Lake at the foot of Mt. Konocti, and the Blue Lakes Resort. The principal attraction of Soda Bay, however, was not Clear Lake, but mineral springs, just off shore, bubbling

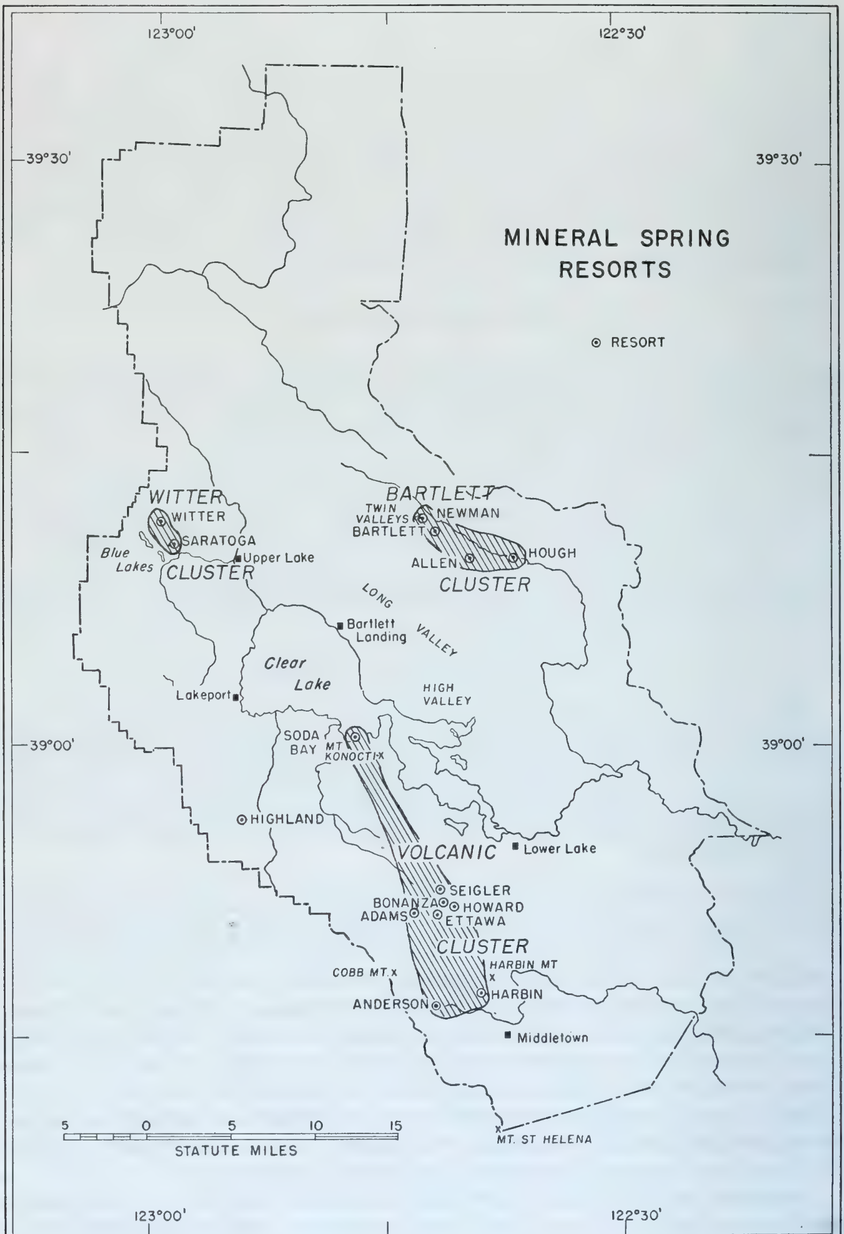

FIGURE 8. Map showing location of mineral spring resorts in Lake County.

FIGURE 9. Hotel at Witter Springs about 1910. Note the isolated position of the resort among the chaparral-covered hills. *Photograph by courtesy of Mrs. Belle Davidson of the Lake County Museum in Lakeport.*

up from the floor of the lake. The picturesque Blue Lakes Resort was thus the only important early resort not associated with a mineral spring.

Lake County Resorts. The Harbin Spring Resort, established in 1852, is generally considered to be the first such development in the county. Soon other resorts were built, until by 1880 all the important Lake County springs had been located and developed. From the start,

FIGURE 10. Stages stopping at Middletown near the important resort area in the volcanic upland of Lake County, about 1910. *Photograph by courtesy of Mrs. Belle Davidson.*


TRANSPORTATION ROUTES
SERVING LAKE COUNTY
1910
RAILROADS
ELECTRIC RAILROADS
STAGE ROADS
FERRIES
GLENN
COLUSA
MENDOCINO
LAKE
SONOMA
NAPA
YOLO
HULLVILLE
LEESVILLE
WILLIAMS
UKIAH
UPPER LAKE
BARTLETT SPRINGS
BARTLETT LANDING
LAKEPORT
SULPHUR BANK
SODA BAY
KELSEYVILLE
HIGHLAND SPRINGS
HOPLAND
PIETA
LOWER LAKE
RUMSEY
GLENBROOK
KNOXVILLE
CLOVERDALE
MIDDLETOWN
HEALDSBURG
CALISTOGA
ST. HELENA
SANTA ROSA
VACAVILLE
NAPA
PETALUMA
VALLEJO
SAN PABLO BAY
SAN RAFAEL
SAUSALITO
SAN FRANCISCO
OAKLAND
NORTHWESTERN PACIFIC
SOUTHERN PACIFIC
S.P. R.R.
NAPA VALLEY ELECTRIC R.R.
RUSSIAN RIVER
39°
38°
123°
122°
0 5 10 15 20 MILES
FJS

FIGURE 11.

even though transportation was crude and expensive and accommodations primitive, the Clear Lake Upland resorts attracted large numbers of summer vacationers from the San Francisco Bay area and from the Sacramento Valley. Health seekers eagerly rushed to the new resorts, often willing to tolerate numerous inconveniences in order to partake of the waters.

At first, visitors arrived at the springs by horseback or wagon, but when good roads were built, stage routes were organized to carry guests to the spas. The most popular route from San Francisco in the late 1870's was a 4-hour journey, by steamer to Vallejo, thence by train to Calistoga. From Calistoga there were two stage lines running on alternate days, one leaving for Lakeport by way of Mt. St. Helena to Middletown thence across Cobb Mountain to the important resort area. The second stage went over Mt. St. Helena, too, and then on to Lower Lake where passengers continued on to Soda Bay, Lakeport, or Bartlett Landing by lake steamer. The journey from San Francisco to Calistoga was relatively comfortable, but the final stage trip over the mountains to the resort country was not a pleasant one and the city people complained about the roughness of the road, the abundance of the dust, and the summer heat (*Pacific Rural Express,* April 14, 1877, p. 226, and Aug. 9, 1879, p. 82). The Witter and Bartlett clusters were usually reached by stage routes connecting with the rail towns of Cloverdale, Pieta, Hopland, and Ukiah to the west and Williams to the east.

The appeal of the mineral spring resorts was twofold: health and recreation, although the therapeutic value of the waters was by far the most important advertising point. Numerous physicians were drawn into association with the resorts, some as promoters and developers, others as resident physicians in the summer season, and still others as authors of testimonials. Many of the resort names had important "health" connotations. So that health seekers might know the qualities of each spring, chemical analyses were published and extensive comparisons made between their waters and those of the celebrated spas of the East and Europe. Word of the supposed curative powers of springs for specific diseases or ills spread quickly throughout northern California. Witter Springs' reputation for the curing of venereal diseases became so well known that visitors to that resort were the butt of humor about their supposed illnesses.[8] This reputation is considered by some to have been an important element in the decline of Witter Springs and the dismantling of its large hotel. Pleasantness of taste was another factor in preference for the waters of different springs and although its relative importance cannot be accurately measured, it seems likely that the popularity of Bartlett Spring was in part because of its pleasantly carbonated water.

Recreational activities at the resorts were subdued in character. Strenuous activities were not usual. Croquet, bowling, billiards, swimming and bathing, and dancing were enjoyed. Horses were provided for those who wished to ride. Hunters sometimes stayed at resorts, but they usually preferred the less elaborate ones.

The more successful of the resorts became considerable establishments with facilities for hundreds of guests. Hotels, cabins, bath houses,

[8] Despite the joking about Witter, it was considered a powerful cure for syphilis and stories are seriously advanced by oldtimers about its effectiveness even today.

FIGURE 12. Croquet grounds at Anderson Springs, about 1910. *Photograph by courtesy of Mrs. Belle Davidson.*

stables, and stores were constructed. In the busy summer season scores of employees were kept fully occupied. Each resort had a wide range of rates. Hotel rooms were available for those who desired a maximum of comfort, cabins for families who wished to do their own housekeeping, and camping facilities for the robust. The most successful of the resorts sometimes did away with camping privileges, but there were always less prosperous neighbors nearby who were eager to obtain this trade.

The spring resorts, isolated among chamise or woodland, suffered from costly fires in the dry summer season. Flames swept with startling speed through the wooden resort buildings, many of which had to be rebuilt more than once.

The economics of the operation of mineral spring resorts may be understood by considering the activities at Bartlett Springs Resort. The main spring was discovered in 1867 by a rheumatic wanderer. Bartlett became the largest and most successful resort in all of Lake County, largely because of energetic promotion. Its several springs were all cold, and, while baths were provided, principal reliance was placed on drinking the waters which contained sulphur, magnesia, potassium, soda, borax, and other ingredients in varying amounts. The main spring, Bartlett Spring, had naturally carbonated water which was very pleasant to taste. By 1877 Bartlett Resort was so popular that the springs were visited by as many as seven hundred people in one day (*Pacific Rural Press,* April 14, 1877, p. 226). There were nearly 100 cottages and cabins at Bartlett Springs in 1890, as well as a new hotel. Eventually there were three big hotels, stables, a post office, and stores at the resort. Operations were so successful that for a time the facilities were kept open all winter.

In July and August from four to six stages went into Bartlett Springs every night, most of them from Williams, where they connected with the Southern Pacific Railroad. It took four hours to travel the 40 miles from Williams to Bartlett by stage. Another route wound

*Production of bottled mineral water in Lake County.**

Year	Gallons	Value	Year	Gallons	Value
1895†	87,500	$42,000	1905	489,000	$219,500
96	65,920	32,460	06	365,000	160,000
97	511,950	76,585	07	304,340	130,936
98	523,000	37,350	08	246,545	118,300
99	166,020	75,924	09	265,000	108,270
1900	758,600	45,400	1910	212,546	95,005
01	201,706	120,360	11	227,440	58,933
02	241,100	126,663	12	202,000	114,500
03	381,040	187,621	13	209,750	109,938
04	659,000	221,000	14	254,150	47,267
			15	165,130	24,371

* From Averill, 1947, p. 18.
† Figures for all springs not reported before 1895.

over steep Bartlett Mountain from the lakeside landing where the Bartlett Springs steamboat put in, bringing new vacationers from the west.

Bartlett Springs, with its several hundred summer guests, had a considerable commissary problem. Farmers and ranchers from Upper Lake, High Valley, Long Valley, Twin Valleys and parts of Colusa County all helped supply the resort. A meat market was maintained at the resort for those who did their own housekeeping. For a while animals were slaughtered at the resort and from time to time herds of cattle were driven over Bartlett Mountain by an Upper Lake contractor. Later, however, this contractor slaughtered the animals at Upper Lake and hauled the meat over by wagon. Fresh vegetables were carried to the resort from Upper Lake every other day. Homesteaders in Colusa County and in the eastern hills of Lake County also helped meet Bartlett's needs. Hundreds of tons of hay, used as feed for riding horses kept at the resort, were supplied by nearby ranchers. In the early years of the twentieth century motor traffic replaced horse-drawn vehicles. This change led to an increase in the purchase of supplies at greater distances where prices were lower, and to a gradual decline in prosperity and population in the eastern hills.

Like Bartlett Springs, the other resorts constituted a considerable market for Lake County labor and agricultural produce. Road-construction especially was stimulated. In summer, a regular passenger boat was operated on Clear Lake. Altogether, the Clear Lake economy received a real stimulus from the resort industry, which encouraged diversified farming by creating a demand for a variety of vegetables and fruits.

As the reputation of the springs grew, a considerable demand for their waters arose, and bottling works were established at many of the resorts. In the early days, barrels, and in some cases bottles of water, were hauled by wagon in summer over the rough roads from the springs to outlying markets. Waters were marketed mostly in northern California, where they were known. However, some bottles reached Honolulu, Alaska, and Central America. The output of Lake County mineral water increased steadily, reaching a peak at the turn of the century, declining thereafter.

With the coming of the automobile, striking improvements were made in California's road system. Many people in northern California who

formerly found the resorts of the Clear Lake country a reasonable distance to travel for a summer vacation now went farther afield for their extended holidays. Lake County was now thought of more as a weekend resort center within easy reach for a few days' relaxation. New lakeside and mountain resorts developed that were more in keeping with the demands of the day and a new generation grew up untutored in the joys of spending a few weeks bathing, drinking mineral water, riding, dancing, playing croquet and reading in the seclusion of a mineral spring retreat. Instead of rest, quiet, and rural recreations, the modern resorts featured city comforts and pleasures in the fresh air of the mountains.

The inevitable decline of the old resorts was accelerated by the state highway building program of the twenties that left many of them isolated in the hills and difficult of access from the new local routes. Bartlett Springs, after a vigorous but unsuccessful struggle to have the Ukiah-Tahoe highway run east by way of the springs, lost business steadily and was ruined by a disastrous fire in 1934. Only in the volcanic upland and near the Blue Lakes did any of the spring resorts survive and even in these places they appear today as subdued remnants of a past era. Attempts to market mineral water as a mixer have not been very profitable, but a few of the well-known old springs, such as Bartlett and Witter, still maintain small bottling works that operate intermittently to supply small amounts of water to the few people who remember their early reputations.

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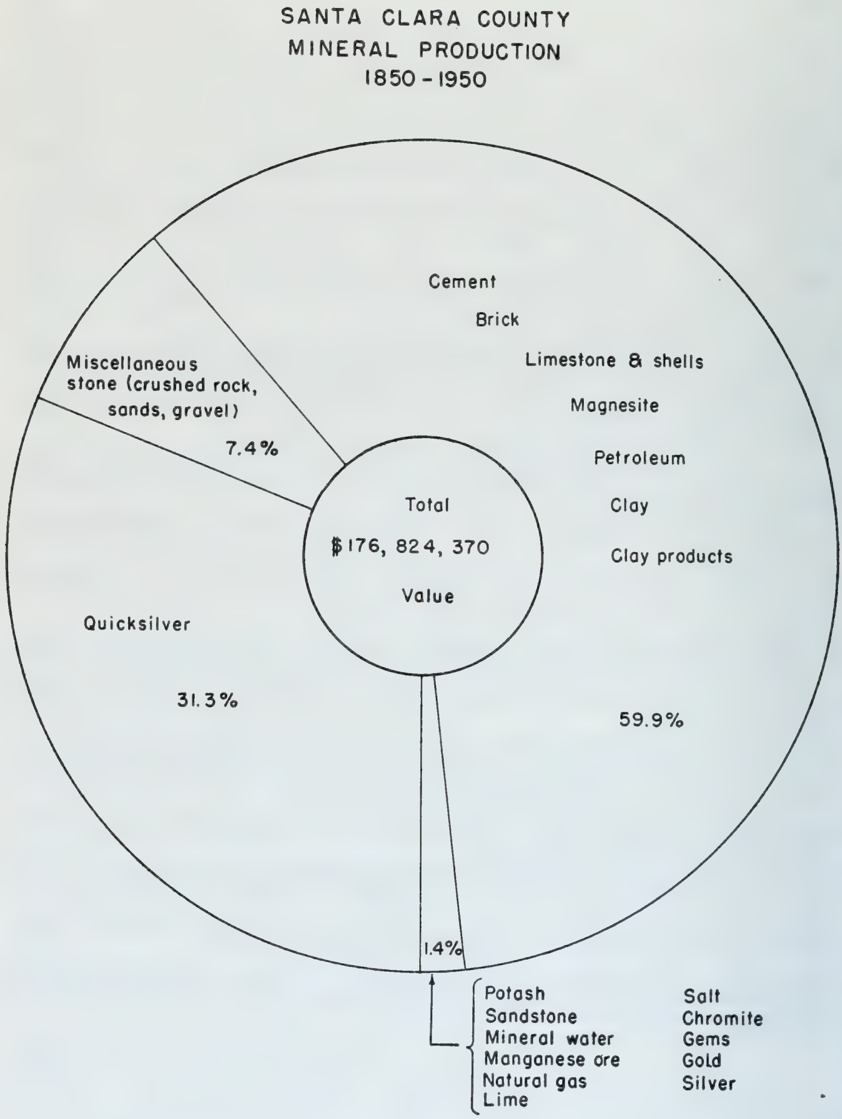
SANTA CLARA COUNTY
MINERAL PRODUCTION
1850 - 1950
Cement
Brick
Limestone & shells
Magnesite
Petroleum
Clay
Clay products
59.9%
Miscellaneous stone (crushed rock, sands, gravel)
7.4%
Quicksilver
31.3%
Total
$176, 824, 370
Value
1.4%
Potash
Sandstone
Mineral water
Manganese ore
Natural gas
Lime
Salt
Chromite
Gems
Gold
Silver

FIGURE 1.

MINES AND MINERAL RESOURCES OF SANTA CLARA COUNTY, CALIFORNIA

By Fenelon F. Davis * and Charles W. Jennings **

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ABSTRACT

Santa Clara, one of the central Coast Ranges counties of California, embraces 1,305 square miles at the southern end of San Francisco Bay. The Santa Clara Valley, trending northwestward through the center of the county, is flanked by the Santa Cruz Mountains on the west and by the Diablo Range on the east.

The oldest rocks found within the limits of the county are included in the Franciscan-Knoxville group of Upper Jurassic (?) age. These rocks form the largest mappable unit in the area and are exposed in the mountains on both sides of the valley. Cretaceous marine sediments locally overlie the Franciscan in the Diablo Range and are found also in the Santa Cruz Mountains. Miocene sediments border the San Andreas fault in the southern Santa Cruz Mountains, and occur in a belt in the northern Diablo Range. Marine and continental Pliocene sediments crop out in patches along both margins of the Santa Clara Valley. The valley floor is composed of a vast accumulation of sand and gravel of Quaternary age. Tertiary volcanic rocks occur locally on both sides of the valley.

The value of the total recorded mineral production for the county, 1850-1950, is \$176,824,370. Santa Clara County ranked tenth among the 58 counties of the state in value of mineral production for 1950. The value for that year totaled \$13,814,298; mineral materials produced included cement, sand and gravel, crushed rock, clay, limestone and shells, quicksilver, magnesite, and petroleum. Chromite, manganese ore, sandstone (dimension), and mineral water have been produced in former years.

Chromite was mined in the Red Mountain district of the Diablo Range and on the east slope of the Santa Cruz Mountains during World War I. No production was reported from 1919 to 1951 inclusive. During 1952 new discoveries were made in the hills north of Edenvale, and on the O'Connell Ranch east of Morgan Hill. A mill to concentrate the ore from these deposits was constructed northeast of Edenvale in 1952. The total recorded production of chromite in the county to the end of 1952 has been 516 long tons.

The occurrence of copper has been noted on Hooker Creek south of Los Gatos, and near the town of Almaden.

Small amounts of gold have been found in the gravels of Stevens Creek, and in the vicinity of Lexington and Hooker Creek south of Los Gatos.

Santa Clara County ranks third among the counties of the state in the number of known manganese localities, and ranks seventh in quantity of production. Actual

production of manganese ore to December 31, 1951, totaled 8,942 short tons. Manganese deposits are located in the Diablo Range about 25 miles east of San Jose. The ore occurs in lenses of white chert interbedded with shale and sandstone of the Franciscan formation of Jurassic (?) age.

The New Almaden quicksilver mine 10 miles south of San Jose is the oldest metal mine on record in the state. It boasts a 77-year record of continuous production beginning in 1850, during which period more than a million flasks of quicksilver were produced. The Guadalupe mine, located 5 miles northwest of the New Almaden mine, is the sixth largest quicksilver producer in the state. The host of all the sizable ore bodies has been silica-carbonate rock, formed by the alteration of serpentine sills which had previously intruded shale and sandstone members of the Franciscan formation.

The Permanente Cement Company constructed their plant on Permanente Creek in 1939 as a two-kiln unit. Expansion of the plant continued during and following World War II until the annual output reached 7,000,000 barrels in 1952. Five kilns are now in operation. Clay for cement is obtained from a bed of altered andesite which crops out on a mountain spur between the limestone quarry and the cement plant. This material is supplemented by lateritic clay and pyrite sinter obtained outside the county. Limestone is obtained from the highly fractured and contorted Calera member of the Franciscan formation (Jurassic?).

Common clay has been mined and used in the production of brick and tile since the Mission period in the 18th century. A brick plant established in 1863 along the east bank of Coyote Creek about a mile south of San Jose is still in operation. Other clay pits are located in the vicinity of San Jose on Coyote, Los Gatos, and Guadalupe Creeks. In the manufacture of sewer pipe, roofing tile, and flower pots, the local clay is nearly always blended with ceramic clays obtained outside the county.

Occurrences of limestone have been noted in formations ranging from Jurassic to Recent in age. The only commercial production, however, has been from the Calera limestone member of the Upper Jurassic (?) Franciscan formation; discontinuous outcrops of limestone are found along the east slope of the Santa Cruz Mountains. The Franciscan limestone is interbedded with chert and the principal production from this formation has been made at Black Mountain for the Permanente cement plant. Limestone has been calcined to lime at both Guadalupe and Los Gatos Creeks, although no such activity has been reported since 1913. Shells from southern San Francisco Bay, processed at Alviso, have been a source of lime in recent years.

The principal production of magnesite has been made from the Western mine in the Red Mountain district about 25 miles east of San Jose. The deposits consist of veins and lenses of magnesite formed by the replacement of serpentine. The serpentine, a sill-like body, is intrusive into the Franciscan formation. A small quantity of magnesite was produced from deposits in the vicinity of the Cochrane Ranch 3 miles east of Madrone. Only a token production of magnesite has been made in the county since the end of World War II.

Mineral springs are found in the mountains on both sides of the Santa Clara Valley. No commercial production has been reported since 1932.

Crushed rock for roads and fill has been produced from igneous, sedimentary, and metamorphic deposits within the county. Along the east side of the Santa Clara Valley the Monterey formation of Miocene age and the Oakland conglomerate of Cretaceous age have been the principal sources. Along the west side of the Santa Clara Valley, the chief sources of road rock have been Miocene basalt flows, Lone Hill rhyolite, and metamorphosed Franciscan sandstone. Fill rock has been obtained from sedimentary beds of the Santa Clara formation, friable Purisima sandstone, serpentine, and furnace calcine from the dump of the Senator quicksilver mine.

The chief sources of sand and gravel have been Coyote and Los Gatos Creeks. Smaller quantities have been obtained in Guadalupe and Carnadero Creeks, and occasional production has been made from Llagas and Pacheco Creeks.

Serpentine has been quarried and fused with phosphate rock. The fusion-product was sold as a fertilizer.

Dimension sandstone was quarried on the south flank of the Santa Teresa Hills from 1900-05. This stone was used in construction of campus buildings at Stanford University, and for many other buildings in California.

Some of the earliest oil prospecting in California was conducted around oil and asphalt seepages at Moody Gulch and Sargent. The first well on the contorted homocline at Moody Gulch was drilled in 1878. The wells averaged 1200 feet in depth and produced 10 to 40 barrels per day from the San Lorenzo shale of Oligocene age.

A single well was producing 1 to 2 barrels per day in 1951. The cumulative production of petroleum from Moody Gulch in 1952 was over 63,000 barrels. The gravity of the oil ranged from 40 to 45 degrees Baumé.

Drilling for petroleum on the Sargent Ranch began in 1886 but only 20,000 barrels were produced by 1904. It is believed that a faulted anticline is responsible for the accumulation of oil and the seepages that occur in this field. The peak production, 63,780 barrels, was attained in 1909. The field was abandoned in 1948 after an estimated cumulative production of over 780,000 barrels of petroleum. The gravity of the oil ranged from 9 to 11 degrees Baumé.

Ferrosilicon for use in the production of metallic magnesium is made by the Kaiser Aluminum and Chemical Corporation at Permanente. Production of ferrosilicon began in 1942 and continued until 1944. The plant was closed in the latter year and temporarily reopened in 1949. In 1951 the plant was rehabilitated to meet the demands of the Korean war. The raw materials are obtained outside the county and the ferrosilicon is shipped to Manteca, San Joaquin County, where it is consumed in a magnesium plant.

Fiberglass, used for thermal and acoustical insulation, is manufactured at a plant in the town of Santa Clara. The raw materials, including sand, limestone, dolomite, soda ash, and sodium borate (rasorite) are obtained from deposits outside the limits of the county.

Expanded perlite was produced at a plant near Campbell during 1947. The crude perlite was obtained from a deposit in Napa County.

INTRODUCTION

The Santa Clara Valley served as a northern corridor for the parties of Spanish explorers and colonists who, during the latter part of the eighteenth century, frequently travelled between Monterey and San Francisco. In 1769 Portola reported the presence of Indian villages along Guadalupe Creek at the southern end of San Francisco Bay. On November 6 of the same year he pitched camp beneath the lone redwood on San Francisquito Creek which he termed "Palo Alto" (high tree). The Mission Santa Clara, from which the county derives its name, was founded on January 12, 1777, in the vicinity of Agnew. A fugitive from floods and earthquakes, the Mission was moved twice before becoming permanently settled at its present location. (Hoover, M. B., 1937)

Colonization went forward at a rapid pace in the Santa Clara area during the first half of the nineteenth century. Numerous Spanish and Mexican land grants were made and the ranchos were established.

El Pueblo San Jose de Guadalupe was founded November 29, 1777. It became the first state capitol upon the adoption of a state constitution on November 13, 1849, and served in this capacity until February 14, 1851.

Geography. Santa Clara is one of the counties of the central Coast Ranges of California. It embraces an area of 1,305 square miles adjoining the southern end of San Francisco Bay. Neighboring counties include San Mateo and Santa Cruz on the west, San Benito on the south, Merced and Stanislaus on the east, and Alameda on the north.

San Jose is the principal city and the seat of county government. Located on Highway 101, it is 46 miles south of San Francisco and 42 miles south of Oakland. The population of the county in 1950 was 288,852 (California Blue Book, pp. 1005-1010, 1950). It was distributed as follows: San Jose 95,020; Palo Alto 25,290; Santa Clara 11,688; Sunnyvale 9,849; Mountain View 6,548; Gilroy 4,953; Los Gatos 4,880; and Morgan Hill 1,615.

The county enjoys an equable climate with rainless summers. The monthly mean temperature near San Jose ranges from 48° F in January to 67° F in August. Annual rainfall varies from 14 inches on the central valley floor to 30 inches in the flanking mountainous areas.

Coastline trains of the Southern Pacific Railroad pass through the county en route from San Francisco and Oakland to Los Angeles. A branch line of the same company connects San Jose with the coastal resort community of Santa Cruz to the south. A line of the Western Pacific Railroad runs from Oakland to San Jose. An excellent road system totalling over 1,685 miles traverses most of the county.

Topography. The Santa Clara Valley, trending northwestward through the center of the county, is the principal physiographic feature of the area. The valley ranges from about 16 miles in width at its northern end, to about 5 miles in width at the southern boundary of the county. The valley traverses the county lengthwise for about 45 miles and extends an additional 15 miles beyond the southern limits of Santa Clara County to the town of Tres Pinos.

An imperceptible alluvial divide at Morgan Hill, elevation 345 feet, separates the drainage of the county into a north-flowing and a south-flowing system. The former drains into San Francisco Bay at the north end of the county, while the latter leads to the Pajaro River south of Gilroy and eventually flows into Monterey Bay on the coast.

The Santa Clara Valley is flanked by two mountain ranges which are part of the central Coast Ranges of California. On the west the Santa Cruz Mountains separate the valley from the sea. The crestline is formed by steep-sloped peaks reaching elevations of 2,000 to 3,400 feet. The highest point, Loma Prieta Peak, about a mile east of the ridgeline, attains an elevation of 3,806 feet. On the east, the Diablo Range separates the Santa Clara Valley from the San Joaquin Valley. This range consists of several parallel ridges and small intervening valleys. Copernicus Peak, near the Lick Observatory at Mt. Hamilton, is the highest point in the county—4,372 feet.

Industries. The rich alluvial soil of the Santa Clara Valley supports the important agricultural industry in Santa Clara County. The value of agricultural products in 1949 totalled $66,041,332. Fruit and nut crops accounted for about one-third of the total. Forty percent of the California prune crop was produced in this county. Other agricultural items include truck crops, livestock, dairy products, poultry, and nursery products.

The advantageous industrial location and the favorable climate have contributed toward the rapid growth of manufacturing in the county during the past decade. Important groups in this industry are food products, machinery, wood products, and ceramics.

GEOLOGY

The geology of Santa Clara County is typical of the southern Coast Ranges and much of what is said here may be applied equally well to the coastal belt from San Francisco south to the region of northern Santa Barbara County. In the discussion of the geology of Santa Clara County frequent reference will be made to the three prominent phys-

Summary of economic geology of Santa Clara County.

Geologic age		Formations	Rock types	Mineral deposits
QUATERNARY	Recent	Alluvium	Assortment of sand, gravel, and silt.	Aquifers, sand, gravel, clay.
	Pleistocene	Santa Clara	Unconsolidated continental gravels and clay, with interbedded volcanics.	Road metal and fill material.
TERTIARY	Pliocene to Upper Miocene	Purisima	Fossiliferous sandstone and gravel. Some siltstone and clay. Basal conglomerate. Partly marine and partly continental.	Petroleum reservoir rock at Sargent oil field.
		Orinda	Loosely consolidated nonmarine conglomerate, sandstone, and clay.	Contains aquifers.
	Miocene	Briones	Thick-bedded, massive, highly fossiliferous sandstone. Marine.	Aquifer.
		Monterey group	Marine. Diatomaceous and siliceous shale, and sandstone. Fossiliferous.	Petroleum, chert for road surfacing, fill material, mineral springs.
		Vaqueros	Coarse conglomerate and breccia. Basal fossiliferous sandstone. Marine.	Building stone (locally).
	Oligocene	San Lorenzo	Assortment of sandstone and sandy shale. Partly fossiliferous. Marine.	Petroleum at Moody Gulch oil field.
	Eocene		Hard dark shale and sandstone with volcanic intrusives.	
MESOZOIC	Cretaceous	Chico, Berryessa	Principally sandstone, siltstone, and some shale. Marine.	Building stone, road metal.
		Oakland conglomerate	Mostly coarse conglomerate. Marine.	Road metal and fill; aquifer.
	Upper Jurassic	Knoxville—Franciscan	Marine sandstone, shale, siltstone. Locally conglomerate, radiolarian chert, and limestone. Serpentine and ultrabasic intrusions common.	Quicksilver, magnesite, chromite, limestone, manganese, road metal, rip-rap.

iographic units—the Santa Cruz Mountains, the Santa Clara Valley, and the Diablo Range.

The oldest rocks found within the limits of Santa Clara County are included in the Franciscan-Knoxville group of Upper Jurassic (?) age. These rocks form the largest single geologic unit in the area. Overlying the Jurassic rocks locally are marine sedimentary rocks of Cretaceous age. Bordering the San Andreas fault, and in isolated patches in the Diablo Range, Miocene beds occur. Along the margins of Santa Clara Valley, Pliocene strata are exposed and the valley floor itself is composed of an accumulation of Quaternary clay, sand, and gravel. Tertiary volcanic rocks are scarce and in the few isolated localities where found they occur only as small local bodies.

Structure

The structure of Santa Clara County is complex. It is controlled by faulting, the trend of which is predominantly in a northwesterly direction characteristic of the general structural trend of California. In many places folding and crumpling of the sediments are associated with faulting. The most notable faults in the area, and indeed, the major features of the central Coast Ranges are the San Andreas, Hayward, and Calaveras faults. Other prominent related faults of lesser extent are the Sargent, Silver Creek, and Madrone Springs faults.

The San Andreas fault, together with one of its prominent branches, the Sargent fault, subparallels the western boundary of Santa Clara County and separates Miocene strata from Upper Jurassic (?) rocks. The Calaveras and Hayward faults are nearly parallel to each other on the western side of the Diablo Range. These three major fault systems—San Andreas, Hayward, Calaveras—are predominantly of the strike-slip type with probably large right-lateral displacements (east blocks moved relatively south). Two important faults branching off the Calaveras are the Madrone Springs fault and the Silver Creek fault.

Numerous northwest-trending folds in the Tertiary beds have been mapped. Folding within areas of Upper Jurassic (?) rocks, however, is not so well known because persistent axes cannot be traced with certainty.

Rock Formations and Their Relation to Mineral Resources

After the soils, the most important geologic products in Santa Clara County are deposits of limestone, miscellaneous stone, clay, and quicksilver. Magnesite and petroleum are of lesser value. Manganese, chromite, copper, gold, and mineral water also occur, but have been produced in comparatively small quantities.

The occurrence and relationship of these mineral deposits to geologic formations are of importance in evaluating the extent of known workings and in prospecting for further deposits. It is the purpose of this section to describe the various rock groups found in Santa Clara County and to show their relationship to the mineral resources which they contain. For this purpose, a geologic map (plate 2) has been compiled showing the areal distribution of the rock formations and the location of the individual mines.

Franciscan-Knoxville Group. The Franciscan-Knoxville group (Upper Jurassic ?) includes a thick section of predominantly marine strata with associated intrusions of basic rocks. The greater part of the Diablo Range and most of the low foothills in the Santa Cruz Range which border the west side of the valley, consist of such rocks. The beds are primarily sandstone with lesser amounts of interbedded siltstone and shale. Locally, conglomerate, radiolarian chert, altered volcanic rocks, and agglomerate are exposed. Basic igneous intrusions, largely gabbro and peridotite of probable late Jurassic age, have largely been altered to serpentine and schist. The serpentine in turn is commonly altered to silica-carbonate rock by hydrothermal solutions related to Tertiary or Quaternary volcanism. The Franciscan formation is overlain locally by Knoxville rocks which are generally dark gray shale and siltstone. Because of many similarities in lithology and poor exposures, numerous difficulties arise in differentiating the Knoxville formation from the Franciscan formation. Geologists therefore often group these two formations together.

Most of the important mineral resources of Santa Clara County are found within the Franciscan formation. These mineral commodities include quicksilver, magnesite, chromite, limestone, and manganese.

The large degree of fracturing in the serpentine and associated sediments has favored deposition of quicksilver by Tertiary or Quaternary volcanism. In general, the quicksilver minerals are found in interstices of porous, brecciated rocks. In many places the quicksilver ore is richest beneath such impervious material as fault gouge, clay shale, or dense volcanic rock. In the New Almaden district, and in other quicksilver mining localities in Santa Clara County, the ore is commonly associated with silica-carbonate rock occurring on the margins of serpentine masses.

Magnesite deposits at Red Mountain in the Diablo Range, as well as the other less important deposits in the county, consist of cryptocrystalline nodules and veins within ultrabasic intrusives in the Franciscan formation. The magnesite is concentrated in shear zones and was deposited mainly as a replacement of serpentine, but to some extent as fissure-fillings.

Commercial deposits of chromite originate in intrusive masses of ultrabasic rock, and in Santa Clara County such rock types are only found in the Franciscan formation. These ultrabasic rocks are either partly or completely altered to green serpentine. The bodies of ore are either irregularly shaped elongate lenses of chromite, or disseminations of chromite in serpentine. Some of these chromite deposits are believed to have formed as an original constituent of the rock. In other localities the ore bodies are considered to have been emplaced along shear planes as a late hydrothermal feature after partial consolidation of the rock (Allen, 1946).

Limestone deposits constitute an important economic phase of the Franciscan formation. In Santa Clara County the most important quarries are those of the Permanente Cement Company. The limestone in the Permanente quarries lies within the San Andreas fault zone as fault slivers within the Franciscan sandstone and shale.

Much of the manganese ore is found in chert within the Franciscan formation. The deposits in Santa Clara County occur principally in

the extreme northeastern corner of the county. The ore follows the bedding and although locally it has been hydrothermally altered, it is of sedimentary origin. The ore bodies range in size from mere pods or lenses a few inches long to bodies several hundred feet in length. The most abundant primary ore mineral is fine-grained rhodochrosite, which is commonly cut by widely spaced quartz veinlets.

Cretaceous Sedimentary Rocks. Cretaceous strata in Santa Clara County include rocks that have been mapped as the Chico formation by Branner, Newsom, and Arnold (1909); the Shasta group, described by Taliaferro (1943, pp. 119-163); and the Oakland conglomerate and Berryessa shale recently described by Crittenden (1951). The lower part of the Cretaceous sediments is mostly coarse cobble and boulder conglomerate; the upper unit is principally sandstone and thin-bedded siltstone. No basic igneous rocks similar to those in the Franciscan-Knoxville group have been found intruding these Cretaceous beds. To a large extent this probably accounts for the fact that little or no mineralization has taken place in these rocks.

Tertiary Sedimentary Rocks. Tertiary strata occupy much of the area between the Calaveras fault, which lies on the west slope of the Diablo Range, and the Santa Clara Valley. In the western part of the county the San Andreas and Sargent faults separate Tertiary strata from the Franciscan-Knoxville rocks.

The oldest Tertiary formations in the area are the upper Eocene Butano and the Oligocene San Lorenzo formations which occur in the vicinity of Moody Gulch. Other Eocene formations, as yet unnamed, lie northwest of Morgan Hill and south of San Jose.

The Miocene epoch is represented by several formations. Beginning with the oldest, they are the lower Miocene Vaqueros formation, middle Miocene Monterey shale, and upper Miocene Briones sandstone. Overlying the Briones sandstone with slight angular unconformity is the upper Miocene-lower Pliocene Orinda formation. The nonmarine Orinda formation lies along the trough of a rather long syncline exposed west of the Calaveras Reservoir.

Long narrow strips of Pliocene-Pleistocene rocks occur on both sides of Santa Clara Valley, principally due west of San Jose and directly east of Morgan Hill. These beds are generally divided into two units, the Purisima and Santa Clara formations. The Purisima is predominantly marine at its base and partly upper Miocene in age; upward the section grades into continental beds. The formation is composed of clay, silt, sand, and gravel. The younger Santa Clara formation, on the other hand, is wholly continental, and is composed predominantly of unstratified loose gravel with interbedded volcanic flows and tuffs.

The Tertiary beds include the oil-bearing formation of Santa Clara County. The petroliferous formations are the Monterey and Purisima at Sargent oil field and the San Lorenzo at Moody Gulch oil field. A detailed discussion of these oil fields, including their structure and geology, may be found in a later section of this report.

The sandstone member of the Vaqueros formation is used locally as dimension stone. It is friable and easily quarried, but becomes indurated on exposure to the atmosphere.

The cherty layers of the Monterey formation are quarried for fill and road metal. The chert does not decompose and packs to a hard surface. The location of established quarries is shown on the geologic map, plate 2; however, similar rock is present at many other places, and the supply of this material is almost unlimited.

The sedimentary beds of the Santa Clara formation contain large quantities of gravel, but it would require much washing to obtain a clean product suitable for building material. However, the heterogeneous sediments of the Santa Clara formation do provide a suitable material for fill and road metal, and several quarries are located in this formation.

Tertiary Volcanic Rocks. Only a few volcanic rocks are found in Santa Clara County, and these occur as small patches in scattered localities. A basalt flow is exposed near Stanford University, overlying rocks of the Purisima formation which are metamorphosed in part. At Alum Rock Park a body of silicified rhyolite is exposed. In the fields and hills just east of Silver Creek (south of Evergreen) is a narrow exposure of black andesite. North of the Guadalupe quicksilver mine a rhyolite dike crops out and on the west side of Guadalupe Creek rhyolite with perlite forms Lone Hill. Northeast of Gilroy volcanic flows are interbedded in the Santa Clara formation. The basalt exposed at Stanford has long been utilized as a source of crushed rock for road metal; the Lone Hill rhyolite is now crushed for the same purpose. Other areas of volcanic rocks in Santa Clara County are small in extent and are therefore only suitable for small-scale local road work.

Quaternary Alluvium. During Pleistocene and Recent times a vast expanse of clay, sand, and gravel was transported via streams and deposited in the Santa Clara Valley. The maximum depth of this valley alluvial fill is not known, but well logs show that it is more than 1,500 feet deep.

The richest soils in the county are those represented by Quaternary alluvium. These soils are derived from the surrounding hills and from the decomposition of the gravel in the underlying alluvium. Where the strata are composed of diatomaceous shale or very pure siliceous sandstone the resulting soil is exceedingly poor. This is quite characteristic of the Monterey formation and is generally true of the Vaqueros sandstone. On the other hand, rich soils are often produced in areas of Franciscan rocks as the result of the decomposition of limestone, greenstone, and metamorphic rocks.

The alluvial fill of Santa Clara Valley also serves as the most important reservoir rock for water. Wells are drilled to penetrate the gravel beds which underlie practically the whole valley floor.

Quaternary creek beds provide sand and gravel suitable for concrete aggregate and roadbed material. The creek beds also provide low-grade clay deposits such as those on Coyote Creek.

MINES AND MINERAL DEPOSITS

The recorded mineral production of Santa Clara County, 1850-1950 inclusive, is valued at $176,824,370. Quicksilver production from mines in the vicinity of New Almaden accounted for 31 percent of this figure. Cement production has been an important item during the past 10

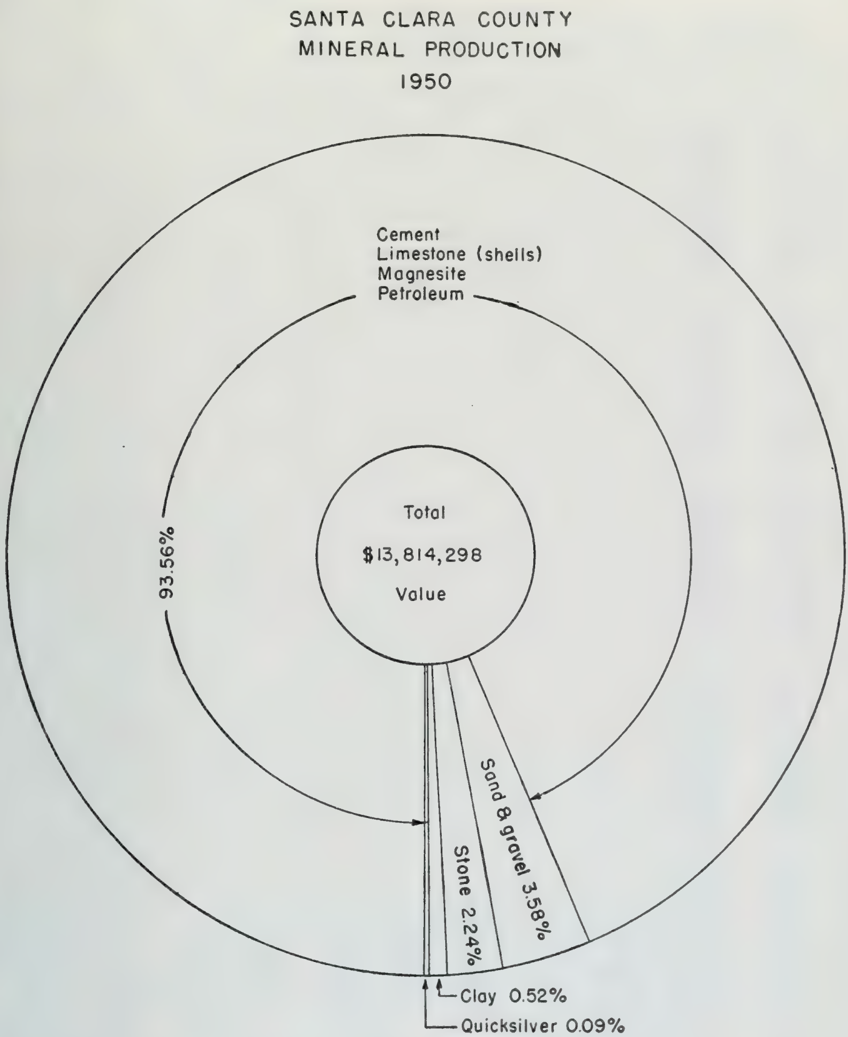


FIGURE 2.

years and a large share of the remaining value can be attributed to this commodity.

Santa Clara County ranked tenth among the 58 counties of the state in value of mineral production during 1950. Mineral commodities produced in that year amounted to $13,814,298.

In addition to the commodities mentioned in tables 1 and 2, the occurrence of the minerals listed in table 3 has been reported in bulletins of this Division (Murdoch and Webb, 1948; Jenkins, 1951, p. 313) and in publications listed in the bibliography at the end of this report.

Table 1. Mineral Production of

Year	Quicksilver		Mineral water		Petroleum		Brick		Pottery clay		Sandstone	
	Flasks	Value	Gallons	Value	Barrels	Value	M	Value	Tons	Value	Cu. ft.	Value
1850	7,723	$768,052	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1851	27,779	1,859,248	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1852	15,901	927,505	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1853	22,284	1,233,648	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1854	30,004	1,663,722	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1855	29,142	1,560,554	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1856	27,138	1,401,678	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1857	28,204	1,374,381	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1858	25,761	1,232,149	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1859	1,294	81,690	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1860	7,061	378,117	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1861	34,429	1,447,739	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1862	39,671	1,442,041	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1863	32,803	1,380,350	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1864	42,489	1,950,245	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1865	47,194	2,166,205	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1866	35,150	1,867,519	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1867	24,461	1,122,760	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1868	25,628	1,176,325	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1869	16,898	775,618	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1870	14,423	827,592	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1871	18,568	1,171,641	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1872	18,574	1,224,584	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1873	11,042	887,004	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1874	9,084	995,455	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
[3]	20,000	1,098,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1875	16,980	1,428,867	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1876	27,930	1,228,920	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1877	30,237	1,127,840	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1878	24,924	820,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1879	36,054	1,076,212	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1880	30,135	934,185	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1881	31,288	933,321	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1882	29,208	824,542	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1883	29,084	836,165	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1884	20,000	610,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1885	21,400	658,050	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1886	18,000	639,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1887	20,000	847,600	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1888	18,000	765,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1889	13,100	589,500	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1890	12,000	630,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1891	8,200	371,105	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1892	5,563	226,470	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1893	6,614	243,064	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1894	7,235	222,169	5,000	$1,250	3,500	$8,500	22,725	$119,250	-------	-------	24,000	$8,292
1895	7,050	253,800	20,000	5,000	4,000	10,000	24,750	131,250	-------	-------	-------	-------
1896	6,222	211,570	44,000	18,800	900	1,145	15,000	80,000	-------	-------	-------	-------
1897	4,700	169,200	39,500	17,600	4,000	10,000	19,000	105,000	-------	-------	-------	-------
1898	5,875	235,000	25,863	11,358	3,000	6,000	13,098	65,490	200	$2,500	-------	-------
1899	4,435	186,270	79,000	19,150	1,500	3,000	30,741	170,455	-------	-------	-------	-------
1900	5,145	241,073	30,000	8,060	-------	-------	20,000	136,000	2,000	6,000	120,000	100,000
1901	5,220	236,608	55,000	8,500	-------	-------	21,800	94,570	-------	-------	60,000	80,000
1902	5,869	254,260	21,900	5,500	-------	-------	23,982	178,662	-------	-------	35,000	31,500
1903	5,603	233,130	50,000	12,500	4,695	3,966	28,069	188,284	-------	-------	112,350	225,000
1904	[5]3,889	148,103	50,000	12,500	42,000	13,860	24,909	178,581	-------	-------	-------	-------
1905	2,693	95,968	5,000	1,200	41,000	14,555	28,486	204,357	700	1,050	100,000	150,000
1906	2,592	94,608	5,000	1,250	7,000	2,800	23,397	183,676	1,000	1,500	-------	-------
1907	2,518	96,086	11,374	2,187	22,100	5,525	30,053	255,424	-------	-------	3,500	3,500
1908	2,460	103,984	371,635	39,955	35,400	17,700	15,000	63,618	-------	-------	-------	-------
1909	3,747	158,490	373,367	40,754	63,780	76,536	6,000	30,000	-------	-------	-------	-------
1910	4,038	182,719	182,500	11,200	36,660	36,660	12,000	66,000	12,000	66,000	-------	-------
1911	7,533	346,593	165,720	10,000	12,828	8,505	6,000	30,000	-------	-------	-------	-------
1912	8,695	365,538	152,500	10,250	14,092	8,295	18,000	105,000	-------	-------	-------	-------
1913	3,709	149,213	101,000	10,750	20,000	12,000	18,000	95,000	-------	-------	-------	-------

Santa Clara County, 1850-1950.

Limestone		Miscel-laneous stone[1], value	Magnesite		Miscellaneous and unapportioned		
Tons	Value		Tons	Value	Amount	Value	Substance
				80,000 cu. ft.	$4,072	Natural gas.
					800,000 cu. ft.	12,000	Natural gas.
		$33,900					
500	$600	5,000				1,300	Natural gas.
		12,000			32 tons	640	Asphalt.
1,800	3,000	8,000	100	$1,350	5 tons	75	Manganese.
8,000	6,000		39	253			
		917	50	300	17 tons	255	Asphalt.
					2,000 cu. ft.	1,200	Granite.
7,000	7,000	100			21 tons 11 tons	47 132	Bituminous rock. Asphalt.
		12,000					
10,000		3,000					
9,460	15,000						
671	16,694		[4]3,700	33,300			
2,221	1,417	45,142	[4]2,000	24,000	10,017 bbls.	10,017	Lime.
4,284	4,150	75,916	300	3,000	1,000 bbls.	1,000 82,254	Lime. Unapportioned, 1900-1909.
2,417	3,451	68,765	7,560	51,937			
3,374	3,918	62,595					
3,549	4,120	48,228	600	6,000	13,508 bbls.	10,154	Lime.
	4,200	29,377	70	560	13,107 bbls. 2,000 cu. ft.	9,783 500	Lime. Natural gas.

Table 1. Mineral Production of

Year	Quicksilver		Mineral water		Petroleum		Brick		Pottery clay		Sandstone	
	Flasks	Value	Gallons	Value	Barrels	Value	M	Value	Tons	Value	Cu. ft.	Value
1914	2,407	118,063	29,000	10,750	10,000	5,300	15,900	79,500	--------	--------	--------	--------
1915	4,386	376,319	38,400	16,770	16,617	11,067	10,096	57,784	--------	--------	--------	--------
1916	4,016	375,496	50,000	11,300	16,368	10,901	13,100	82,800	2,024	2,293	--------	--------
1917	5,921	639,594	10,230	1,923	18,855	26,152	14,000	80,000	6,014	4,929	--------	--------
1918	3,977	478,524	13,025	1,678	20,499	34,848	6,792	62,000	--------	--------	--------	--------
1919	3,012	271,762	(2)	--------	16,724	26,695	7,250	65,000	2,532	2,232	--------	--------
1920	2,893	233,199	3,360	480	16,095	23,901	11,890	164,680	1,900	4,600	--------	--------
1921	(2)	--------	2,500	275	13,964	26,943	7,501	110,961	1,126	2,300	--------	--------
1922	(2)	--------	3,500	325	(2)	--------	11,409	150,057	3,836	7,372	--------	--------
1923	(2)	--------	(2)	--------	(2)	--------	22,514	282,997	2,202	3,954	--------	--------
1924	(2)	--------	(2)	--------	14,417	20,481	24,271	217,172	5,341	5,666	--------	--------
1925	(2)	--------	(2)	--------	13,828	22,594	24,250	251,059	1,516	3,216	--------	--------
1926	(2)	--------	(2)	--------	(2)	--------	--------	--------	(2)	--------	--------	--------
1927	--------	--------	(2)	--------	11,994	14,212	20,254	199,472	4,373	4,261	--------	--------
1928	(2)	--------	(2)	--------	13,746	15,121	14,622	157,732	3,058	2,063	--------	--------
1929	(2)	--------	10,760	1,076	(2)	--------	14,063	168,872	13,871	13,871	--------	--------
1930	(2)	--------	(2)	--------	(2)	--------	11,592	113,150	3,607	2,259	--------	--------
1931	(2)	--------	(2)	--------	(2)	--------	--------	82,127	2,665	1,826	--------	--------
1932	123	6,459	(2)	--------	12,945	7,125	2,858	25,281	(2)	--------	--------	--------
1933	(2)	--------	--------	--------	(2)	--------	6,395	46,384	(2)	--------	--------	--------
1934	39	2,813	--------	--------	(2)	--------	--------	54,154	701	442	--------	--------
1935	81	5,474	--------	--------	(2)	--------	3,886	44,541	2,778	2,263	--------	--------
1936	166	11,581	--------	--------	(2)	--------	(2)	--------	1,714	2,590	--------	--------
1937	(2)	--------	--------	--------	(2)	--------	22,658	219,087	3,182	5,560	--------	--------
1938	283	19,887	--------	--------	(2)	--------	23,270	236,295	(2)	--------	--------	--------
1939	252	26,098	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1940	1,034	170,837	--------	--------	(2)	--------	(2)	--------	--------	--------	--------	--------
1941	2,644	495,289	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1942	2,333	436,384	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1943	1,736	322,871	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1944	1,699	192,225	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1945	1,646	210,820	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1946	1,203	110,410	--------	--------	(2)	--------	(2)	--------	(2)	--------	--------	--------
1947	586	49,072	--------	--------	(2)	--------	--------	--------	(2)	--------	--------	--------
1948	(2)	--------	--------	--------	(2)	--------	--------	--------	(2)	--------	--------	--------
1949	(2)	--------	--------	--------	(2)	--------	--------	--------	(2)	--------	--------	--------
1950	186	12,739	--------	--------	(2)	--------	--------	--------	(2)	--------	--------	--------
Totals	1,152,045	$55,354,961	1,949,134	$292,391	512,507	$484,387	689,581	$5,431,722	78,340	$148,747	454,850	$598,292

Grand total value $176,824,370

[1] Includes crushed rock, rubble, sand, gravel. Excludes sand-gravel from 1947 to 1950 (inclusive).
(2) See under Unapportioned.
[3] Estimated production of Guadalupe mine previous to 1875.

Santa Clara County, 1850-1950.—Continued

Limestone		Miscel-laneous stone[1], value	Magnesite		Miscellaneous and unapportioned		
Tons	Value		Tons	Value	Amount	Value	Substance
----------	----------	39,093	1,425	14,250	----------	----------	
(2)	----------	98,342	7,623	74,607	----------	340	Other minerals.
(2)	----------	111,974	23,207	232,156	----------	25,028	Chromite, limestone, manganese.
----------	----------	111,304	9,963	99,287	----------	28,341	Chromite, manganese, tile, limestone.
(2)	----------	111,860	9,746	121,872	----------	948,786	Chromite, manganese, clay, tile, potash.
(2)	----------	73,237	10,912	128,924	----------	480,721	Manganese, limestone, mineral water, potash.
----------	----------	129,582	26,612	392,580	----------	89,670	Limestone and potash.
(2)	----------	138,584	25,800	280,000	----------	191,645	Limestone (marl), potash, quicksilver.
8,252	----------	235,125	28,650	301,875	----------	199,282	Limestone (marl), petroleum, quicksilver.
also marble	49,512	314,935	36,390	472,620	----------	196,375	Mineral water, natural gas, petroleum, quicksilver.
(2)	----------	259,023	(2)	----------	----------	648,059	Limestone, magnesite, mineral water, natural gas, quicksilver.
(2)	----------	453,273	(2)	----------	----------	590,718	Limestone, magnesite, mineral water, natural gas, quicksilver.
----------	----------	478,231	(2)	----------	----------	197,998	Clay and clay products.
					----------	352,277	Magnesite, mineral water, natural gas, quicksilver, petroleum.
----------	----------	457,703	(2)	----------	----------	315,228	Magnesite and mineral water.
(2)	----------	467,555	(2)	----------	----------	379,070	Limestone, magnesite, mineral water, quicksilver.
(2)	----------	332,902	(2)	----------	----------	446,757	Limestone, magnesite, natural gas, petroleum, quicksilver, salt.
(2)	----------	409,718	(2)	----------	----------	359,202	Limestone, magnesite, mineral water, natural gas, petroleum, quicksilver.
----------	----------	403,453	(2)	----------	----------	178,894	Limestone,magnesite, mineral water, natural gas, petroleum,quicksilver.
17,250	53,690	220,482	(2)	----------	----------	8,590	Magnesite, pottery clay, mineral water.
30,646	71,557	361,635	(2)	----------	----------	54,635	Magnesite, pottery clay, petroleum, quicksilver.
26,809	84,033	190,958	(2)	----------	----------	54,045	Magnesite, natural gas, petroleum.
30,613	71,381	112,043	(2)	----------	----------	76,974	Gems (jasper), magnesite, natural gas, petroleum.
(2)	----------	318,475	(2)	----------	----------	342,542	Brick, gems, gold, limestone (shells), magnesite, petroleum, silver.
39,379	74,041	262,916	(2)	----------	----------	161,299	Gems, magnesite, petroleum, quicksilver.
98,944	128,793	213,636	(2)	----------	----------	35	Gold.
					----------	1	Silver.
					----------	25,828	Pottery clay, gems, magnesite, petroleum.
59,151	117,763	203,978	(2)	----------	----------	368,507	Brick, pottery clay, magnesite, petroleum.
190,753	227,340	235,720	----------	----------	----------	2,595,155	Brick, cement, gems, lime, magnesite, petroleum.
280,125	319,558	292,843	(2)	----------	----------	4,832,076	Brick, cement, pottery clay, gems, magnesite, petroleum.
(2)	----------	283,789	(2)	----------	----------	8,484,044	Brick, cement, clay (pottery), limestone (shells), magnesite, manganese ore, petroleum.
[6]161,003	258,502	381,910	(2)	----------	----------	7,164,967	Brick, cement, clay (pottery), magnesite, manganese ore, petroleum.
82,925	223,851	520,464	(2)	----------	----------	4,292,128	Brick, cement, clay, magnesite, manganese ore, petroleum.
45,274	138,122	651,021	(2)	----------	----------	4,810,425	Brick, cement, clay, gems, magnesite, petroleum.
(2)	----------	776,625	----------	----------	----------	7,681,828	Brick, cement, clay, limestone,[6] petroleum, serpentine.
----------	----------	462,732	(2)	----------	----------	11,467,114	Cement, clay, magnesite, petroleum, sand-gravel.
----------	----------	189,241	(2)	----------	----------	13,127,826	Cement, clay, magnesite, petroleum, quicksilver, sand-gravel.
----------	----------	312,232	(2)	----------	----------	14,254,374	Cement, clay, magnesite, petroleum, quicksilver, sand-gravel.
(2)	----------	309,656	(2)	----------	----------	12,997,118	Cement, clay, limestone (shells), magnesite, petroleum.
					498,716 tons	494,785	Sand-gravel.
1,124,400	$1,887,693	$11,331,190	194,747	$2,238,871	----------	$99,056,116	

[4] Erroneously credited to Alameda County in reports of those years.
[5] Flasks of 76½ pounds previous to June, 1904; of 75 pounds thence, through 1927; of 76 pounds since January, 1928.
[6] In part shells.

Table 2. Santa Clara County mineral production in 1950.

Substance	Quantity	Value
Clay--------(short tons)--------	94,306	$71,806
Mercury-----(flasks)------------	186	12,739
Sand-gravel--(short tons)--------	498,716	494,785
Stone-------(short tons)--------	471,475	309,656
Unapportioned: Cement, limestone (shells), magnesite, petroleum----------------------	------------	12,925,312
Total value---------------	------------	$13,814,298

Metallic Minerals

Chromite

The metal chromium is tough and extremely resistant to corrosion, and these properties render it exceedingly valuable in the steel industry. Although about a dozen minerals contain chromium, the mineral chromite, $FeO.Cr_2O_3$, is the only one of commercial importance as an ore of the metal. Pure chromite consists of 32 percent iron oxide, and 68 percent chromic oxide. The latter, Cr_2O_3, is often referred to as chrome, and a deposit of chromite is often termed chrome ore. The occurrence of pure chromite, however, is a rarity. In most deposits of chromite the ferrous iron oxide, FeO, is partly replaced by magnesium oxide, MgO (magnesia); some of the chromic oxide is replaced by aluminum oxide, Al_2O_3 (alumina), or by ferric iron oxide, Fe_2O_3. All these replacements of chromite may occur in the same deposit. Thus, the chemical composition of two deposits of chromite may be entirely different. Composition is very important in determining whether a commercial concentrate can be made from a particular deposit. No

Table 3. Minerals reported to occur in Santa Clara County.

1. Acmite
2. Actinolite
3. Alabandite
4. Albite
5. Alleghanyite
6. Almandite
7. Antigorite
8. Apatite
9. Apophyllite
10. Aragotite
11. Arsenopyrite
12. Azurite
13. Barite
14. Bementite
15. Biotite
16. Bornite
17. Braunite
18. Calcite
19. Cassiterite
20. Chalcedony
21. Chalcopyrite
22. Chlorite
23. Chromite
24. Chrysocolla
25. Chrysotile
26. Cinnabar
27. Crocidolite
28. Crossite
29. Cuprite
30. Deweylite
31. Diopside
32. Dolomite
33. Enstatite
34. Epsomite
35. Fluorite
36. Galena
37. Ganophyllite
38. Garnet
39. Glaucophane
40. Gold
41. Gyrolite
42. Hausmannite
43. Hornblende
44. Hydromagnesite
45. Jarosite
46. Jasper
47. Kempite
48. Lawsonite
49. Limonite
50. Magnesite
51. Magnetite
52. Malachite
53. Margarite
54. Mercury
55. Metacinnabar
56. Muscovite
57. Myrickite
58. Olivine
59. Omphacite
60. Opal
61. Pilinite
62. Prehnite
63. Psilomelane
64. Pyrite
65. Pyrochroite
66. Pyrolusite
67. Pyrrhotite
68. Quartz
69. Rhodochrosite
70. Rutile
71. Sepiolite
72. Serpentine
73. Siderite
74. Sphalerite
75. Sphene
76. Stibnite
77. Stilpnomelane
78. Tephroite
79. Tiemannite
80. Tridymite
81. Valentinite
82. Zaratite
83. Zoisite

high-chrome concentrate can be made from a low-chrome chromite. Market quotations for metallurgical-grade chromite are usually based upon a Cr_2O_3 content of 48 percent.

The ratio of chromium to iron is also used to evaluate the utility of a chromite deposit, and a chromium-to-iron ratio of three to one is the standard of comparison. Practically all of the chromium consumed in the metallurgical industry is used in the form of an alloy, ferrochromium, FeCr. This alloy is made from chromite in an electric furnace. It is composed of about 65 percent chromium and about 28 percent iron.

In the Coast Ranges of California, chromite is associated with the basic intrusive rocks of the Franciscan formation, or their alteration products, chiefly serpentine. Chromite may occur as stringers and lenses or as a dissemination of grains through the country rock. Chromite can usually be identified by its black color, its relative weight (specific gravity 4.4), and by its brownish streak.

In Santa Clara County, chromite has been mined in the Red Mountain district of the Diablo Range, and on the east slope of the Santa Cruz mountains between Los Gatos and Gilroy. This work was done during World War I, and the deposits are described in previous reports (Franke, 1930, p. 4; Bodenlos, 1950, p. 274; Walker and Griggs, 1953, pp. 71-73.) During the spring of 1952 a new discovery of chromite was made on the Smith property in the hills north of Edenvale. In 1953 chromite was being produced on the O'Connell Ranch northeast of Morgan Hill.

Smith Property. Location: About five miles southeast of San Jose, on the south side of Coyote Road, between Senter Road and Coyote Creek; sec. 35 and/or 36, T. 7 S., R. 1 E., M.D., projected. Owner: Fred D. Smith, 599 South San Tomas Road, Campbell.

A range of low rolling hills north of Edenvale rises about 150 feet above the floor of the Santa Clara Valley to an elevation of 328 feet. The hills are about half a mile wide and extend eastward to Coyote Creek, a distance of about 2 miles. Serpentine crops out over the entire area and prospecting disclosed the presence of chromite.

Trenching was done with a D-8 Caterpillar bulldozer and rooters. Four widely separated transverse bulldozer trenches had been made by June 1952, and are described as follows (proceeding from west to east): Trench No. 1 at the west end of the property was 20 feet deep, 15 feet wide, and 200 feet long. A lens of chromite 3 feet thick and 20 feet long was exposed near the center of the west face of the cut. A subsidiary cut 15 feet deep, 10 feet wide, and 50 feet long, along the trend of the hills exposed pods of magnesite. Trench No. 2 was 20 feet deep, 10 feet wide, and 100 feet long. Blackish-green serpentine was exposed. Trench No. 3 was 3 feet deep, 10 feet wide, and 100 feet long. Serpentine was exposed which carried a few widely separated veinlets of chrysotile. The veinlets were not over an eighth of an inch thick. Most of them occurred 3 to 9 feet apart, filling fractures in the serpentine. Trench No. 4 was 3 feet deep, 8 feet wide, and 75 feet long. Serpentine was exposed.

A small quantity of hand-picked chromite containing both massive and spotted ore was piled at the west end of the property.

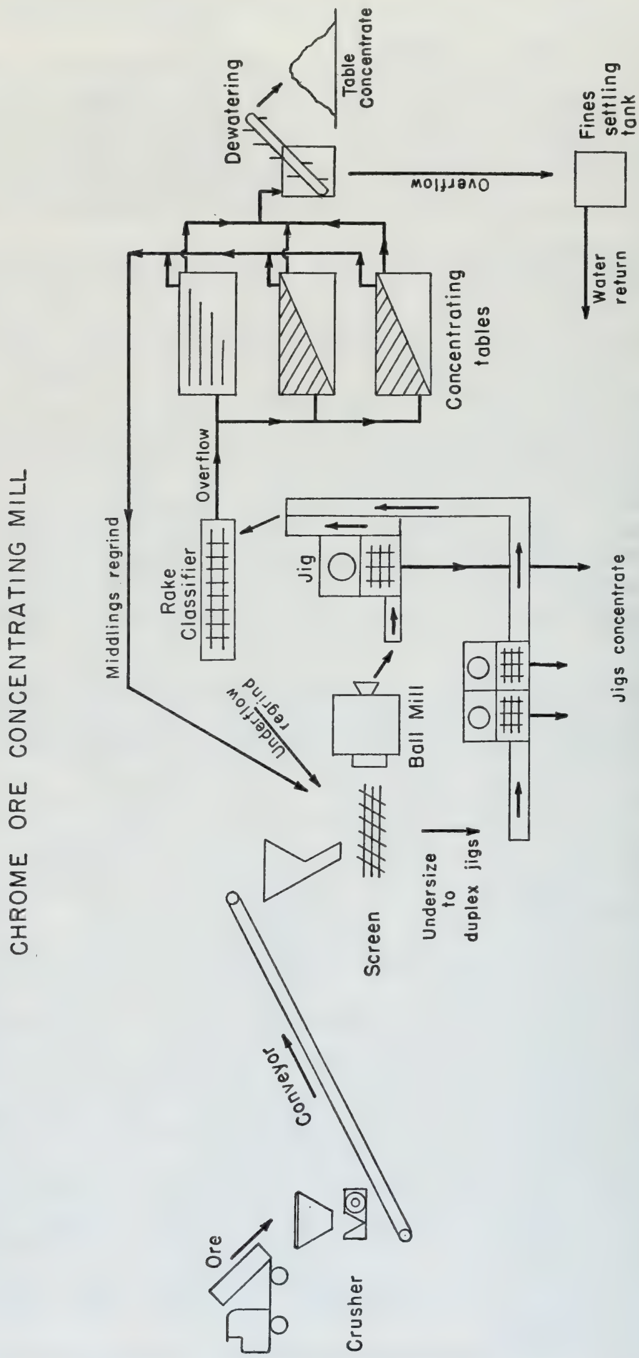


FIGURE 3. Flowsheet for chrome ore mill.

Later in 1952 the Palo Alto Mining Company, 599 South San Tomas Road, Campbell, was organized to mine and mill the ore. The organization included Fred H. Smith, S. S. Ridgely, George E. Carlson, K. R. Dixon, and H. L. Hinkle.

The construction of a mill to handle chrome ore from this property and others in the district was completed in March 1953. The flow sheet included receiving bins, jaw crusher, elevator, feeder, ball mill, jigs, Wemco classifier, one Diester concentrating table, and two diagonal-deck concentrating tables. Test runs were being made on local ore. An assay report on one concentrate showed Cr_2O_3, 32 percent; FeO, 13 percent; chromium-to-iron ratio, 2.2 to 1. A diagrammatic flow sheet of the mill is shown in figure 3.

O'Connell. Location: About 3 miles southeast of Coyote in sec. 31, T. 8 S., R. 3 E., M.D., projected. Owner: O'Connell Ranch; leased to Palo Alto Mining Company, 599 South San Tomas Road, Campbell. A small amount of unrecorded work was done previously in this locality, as testified by the presence of shallow workings. In 1953 the company began prospecting the area along the eastern foothills of the Diablo Range with pits and trenches.

This deposit is located near the center of a northwest-striking peridotite body about 7 miles long and 1 mile wide. The rock cropping out at the surface is a serpentinized peridotite of the Franciscan formation. Numerous bastite crystals can be seen in the surface rocks. The serpentine is cut by longitudinal fractures whose dip is indeterminate. Much of the chromite follows the fractures.

The principal trench is in the form of a ramp, extending from the surface southeastward to a depth of about 60 feet at the southern end. The trench is about 150 feet long and 30 feet wide. Streaks of milling-grade chromite and patches of disseminated chromite in serpentine are exposed in the walls of the trench. The disseminated ore is fractured and is easily reduced in the mill.

Mining is done with a bulldozer and an Allis-Chalmers D-8 loader. The ore is trucked to the mill in two 20-ton dump trucks. About six men are employed.

Copper

Occurrences of copper minerals have long been noted at widely separated localities throughout the central Coast Ranges. Most of these occurrences consist of mineral pockets associated with serpentine or the basic igneous rocks of the Franciscan formation. Generally the minerals malachite, azurite, and limonite are found on the surface at these localities. Underground these minerals grade into chalcopyrite and pyrite and may carry a small amount of gold and silver.

Considerable prospecting has been done, and numerous attempts have been made to develop the deposits. In some instances a small production of copper minerals has been made, but no successful commercial mining operation has resulted.

The principal copper locality in Santa Clara County is at the Hooker Creek (Revelation) mine about 7 miles south of Los Gatos in the Aldercroft Heights district. Occurrence of copper minerals in serpentine near New Almaden has also been reported. A claim on the Hahn Ranch was worked in 1864 and 1865 (Irelan, W. Jr. 1888, p. 549).

Hooker Creek Mine (Revelation). Location: sec. 10, T. 9 S., R. 1 W., M.D. Owner: Dr. H. C. Adair, 870 Market Street, San Francisco.

This prospect near Hooker Creek, 7 miles south of Los Gatos, was discovered in 1900 (Franke, H. A., 1930, p. 7). Some development work was done in 1917 (Huguenin, E., and Castello, W. O., 1920, p. 184), and additional work was done in 1929. Four adits, 20 feet, 235 feet, 85 feet, and 500 feet in length, were open in 1929. A small production of gold and silver was reported in the period 1936-38 (see under *Gold*). In 1952 only two of the adits were open; the other two were completely caved at the portals.

Basic igneous rocks of the Franciscan formation occur in this area. At the portal of ore of the caved adits, serpentinized peridotite is exposed in contact with diabase. The contact is almost vertical and small fragments of botryoidal malachite lay below the exposure. Chunks of massive sulfides consisting of pyrite, pyrrhotite, and chalcopyrite were found nearby. A polished section of one of the specimens was made by Melvin Stinson * who reported the major constituents to be pyrite and pyrrhotite; the minor constituent, chalcopyrite; and that traces of bornite and sphalerite were present.

A lower adit which probably explored the contact is caved at the portal. Adjoining this is the main adit, 5 by 6 feet in cross section and about 400 feet in length. The main adit was timbered near the portal, but ground-water seepage has weakened the frame structure and a cave-in has almost blocked passage just beyond the entrance. This adit has been driven in diabase; a few patches of pyrite and chalcopyrite altered to limonite are found along the walls. Subsidiary workings off the main adit include a raise, a winze, and two short laterals. About 50 feet from the face of the adit a 30-foot lateral explores a mass of crystalline calcite. Another adit, 5 by 6 feet in section was driven from the other side of the hill. No timber was used in this adit and a cave-in has occurred a short distance from the portal.

No production of copper has been credited to this mine, but a small quantity of gold and silver was recovered from the sulfides during the period 1936-38. The mine has been idle since that time.

Gold

A very small quantity of gold was panned in Coyote Creek during pioneer days. About 1870 gold was discovered in the bed of San Francisquita Creek. A short-lived placer camp was established near Mayfield. "Prospects of gold and silver have been discovered in the creeks of the Mount Hamilton group and Santa Cruz Mountains" according to Irelan (1888, p. 549). Small quantities of placer gold have been found in the gravels of Stevens Creek (Branner et al., 1909, p. 11).

The production of a small quantity of gold and silver was reported (Merrill and Gaylord, 1939, p. 249) from the Hooker Creek (Revelation) copper mine between 1936 and 1938 (see under *Copper*). This property is located south of Los Gatos above the Aldercroft Heights district. The gold occurred with pyrite, pyrrhotite, and chalcopyrite in basic igneous rock of the Franciscan formation. The ore was crushed by a jaw-crusher and a ball mill, and the gold recovered by amalgamation. The equipment, including a 6- by 18-foot concentrating table, remained on the property in 1953.

* Junior mining geologist, California State Division of Mines.

Manganese

Santa Clara County ranks third among the counties of the state in the number of known manganese localities, and ranks seventh in quantity of production. Actual production of manganese ore, to the end of 1951, totalled 8,942 short tons. This represented about 5 percent of the total production recorded in California for the same period. During World War II, in the period 1942-46, 5,794 short tons were produced. At that time prices were high and grade requirements were considerably lower. Most of the pre-1941 production of 3,148 short tons occurred during the World War I period, 1916-19, when similar prices and requirements prevailed. No production has been reported from the county since 1946.

Manganese mineralization is widespread in the eastern part of the county where 45 deposits are reported. Although 28 of these deposits have reported production, only two, the Jones and the Keller, have produced over 1,000 tons of ore. This production was used both in the metals industry and in the manufacture of dry cell batteries. Over 90 percent of the manganese ore consumed in the United States enters the steel industry, where 14 pounds of manganese are required per ton of steel.

Most of the manganese deposits are located in the Black Wonder area near Red Mountain, T. 6 S., R. 5 E. Rocks of the Jurassic (?) Franciscan formation are distributed widely in this vicinity. They include arkosic sandstone, shale, chert, greenstone (altered volcanics), schist, and basic igneous intrusive rocks such as gabbro, dunite, and peridotite. The basic intrusive rocks are extensively altered to serpentine. Glaucophane schist and quartz-albite, lawsonite, actinolite, and chlorite schists are also found.

The manganese deposits occur in lenses of white chert interbedded with shale and sandstone. Much of the rock is intensely folded, and some is cut across with veinlets of quartz. The regional strike is northwesterly, and dips range from 40° to 90°. The maximum thickness of the chert lenses is about 250 feet, but many are less than 100 feet thick.

The manganese minerals near the surface are black oxides (psilomelane and pyrolusite). At depth the oxide minerals often pass into rhodochrosite ($MnCO_3$), or bementite (manganese silicate), which are the primary minerals. Low-grade ore may consist of a mixture of chert, quartz, and manganese minerals. Manganese deposits in the county have been described by Trask (1950, pp. 242-265).

The origin of the manganese deposits is attributed to submarine volcanic activity. The normal marine sedimentation on the sea floor was frequently disturbed by eruptions of lava, accompanied by thermal springs; the springs were heavily charged with silica which later settled to the bottom of the sea, forming chert beds. Other springs containing manganese were responsible for the deposition of the primary minerals rhodochrosite and bementite. Eventually the sediments of the sea floor were elevated, folded into a mountain range, and eroded, exposing the manganese deposits. The primary minerals were subsequently converted into black oxides by the action of ground water. The origin of the manganese deposits has been described in considerable detail by Jenkins and Taliaferro (1943, pp. 217-331).

Quicksilver (Mercury)

Quicksilver was first produced in this country from ores mined at New Almaden in Santa Clara County, California. The New Almaden mine, which is 10 miles south of San Jose, is not only the oldest metal mine on record in the state, but also boasts the longest record of continuous production. Over a century and a quarter spans the interval between its discovery in 1824 and its re-exploration in 1952.

The mine originally became world famous as a result of litigation over its ownership and the subsequent settlement by international arbitration. It has since become the largest producer of quicksilver in North America, and fourth largest producer in the world. The only mines which outrank it in total quicksilver production are the Almaden mine, Spain; the Idria mine, Trieste; and the Santa Barbara mine, Huancavelica, Peru. During the period of its productive life, however, total production from the New Almaden mine has been exceeded only by that from the Almaden mine in Spain.

Numerous small quicksilver mines and prospects are distributed through the central part of the county, from the eastern foothills of the Santa Cruz Mountains to the western foothills of the Diablo Range. Evidence of these mines and prospects can be found along Los Capitancillos Ridge, Santa Teresa Hills, Hillsdale Hills, Edenvale Hills and the two elongated ridges between Coyote Creek, Silver Creek, and Dry Creek.

Two major quicksilver mines, the New Almaden and the Guadalupe, were developed on Los Capitancillos Ridge in the New Almaden mining district. The Comstock mine in the southeastern corner of the county is located in the Stayton mining district. Several other mines, which have intermittently produced small quantities of quicksilver, are described in summary form in the table of mines at the end of this report.

Guadalupe Mine. Location: About 10 miles south of San Jose in the N½ sec. 30, T. 8 S., R. 1 E., M.D., projected. Ownership: H. S. Young, R. G. Hudson, B. F. Rabinowitz, estate of J. S. Gregory and Matt Wahrhaftig; represented by Matt Wahrhaftig, Bank of America Building, 12th and Broadway, Oakland.

The Guadalupe mine, located on Los Capitancillos Ridge 5 miles northwest of the New Almaden mine, was discovered during the period of excitement at the latter locality. Although its history has been less spectacular than that of the New Almaden, the Guadalupe mine has produced over 112,000 flasks of quicksilver. This figure is sufficient to rank it as the sixth largest quicksilver producer in the state. Most of the production was derived from the old underground workings (now inaccessible) southwest of Guadalupe Creek at a time when the average price of quicksilver was below $50 per flask.

The geology of the Guadalupe mine has been described by L. S. Hilpert of the U. S. Geological Survey (see Sayers 1942) as follows:

> The rocks of the Guadalupe mining property consist of Franciscan sandstones, shales, and greenstones of Jurassic (?) age and of irregular masses of serpentine which probably intruded the Franciscan rocks in late Jurassic time as roughly tabular bodies of peridotite and pyroxenite. These ultrabasics were later serpentinized. . . .
>
> The ore bodies occur near the margins of the serpentine masses, where they have been altered to silica-carbonate rock. These ore bodies apparently occur

in three distinct ledges of silica-carbonate rock. All are approximately parallel, strike about northwest, and dip from 45° southwest to vertical. They are separated by irregular zones of intimately sheared Franciscan rocks and serpentine. From south to north these ledges are known as the Quicksilver (Guadalupe) vein, Incline Shaft vein, and the Datum vein. The Guadalupe vein is now completely covered by the large dumps adjacent to Guadalupe Creek. The Incline Shaft vein crops out on the hillside, and the Datum vein is completely covered above the mine workings by a mass of serpentine.

The Santa Clara Mining Association of Baltimore began extensive work at the mine in 1856 and continued to operate until 1875. Estimates of production during the 20-year period have been placed at 20,000 flasks. In 1875 the mine was sold to the Guadalupe Mining Company of California who operated the property successfully until 1886 when the mine was closed by litigation. After 14 years of idleness, a new period of activity began in 1900. At that time the Century Mining Company was organized by H. C. Davey and production was resumed in 1901. The company was reorganized in 1906 as the New Guadalupe Mining Company. Production was reported each year from 1901 to 1922.

Litigation in the early twenties again closed the mine and no further production was reported until 1930. Small intermittent production was made between 1930 and 1936. Details of operations up to this time were described in earlier reports of this Division (Ransome and Kellogg 1939; Huguenin and Castello 1920; Irelan 1888).

The Laco Mining Company, headed by H. N. Mason of Los Gatos, leased the property about 1937. The two upper levels off the 700-foot inclined shaft were opened and the water level was kept at a low point by constant pumping. Some old mine-dump and furnace-dump ore was also treated in a battery of 10 retorts at the rate of about 225 tons per month.

Estimates of ore reserves in old mine dumps were made in 1942 and 1943 by the U. S. Bureau of Mines (Sayers, 1942, pp. 4-6; 1943). This work included bulldozer trenching, dragline trenching, hand trenching and sampling. Seven surface holes totalling 1,000 feet were diamond-drilled near the Kelly workings on the northeast part of the property. The results of these studies were consolidated in a later report by Bedford and Ricker (1950a).

As a result of these studies, the Laco Mining Company embarked upon an expansion program about 1944. A large Gould rotary furnace was installed (Huttl 1944). Ore production was increased to 80 tons per day, about 30 percent of which was derived from the dumps; most of the remainder came from an open pit near the collar of the inclined shaft. Some high-grade ore was uncovered near the Kelly workings, and this area supplied the balance of the daily production. The flow sheet included a 10- by 20-inch jaw crusher, a 4- by 64-foot rotary furnace, a dust collector, a bank of nine cast-iron condensers 16 inches by 24 feet in size, three 10- by 20-foot redwood tanks and stack. The company continued to operate until 1947; the reported production during the 10-year period of its lease totalled 3,190 flasks.

A lease on the mine was granted to M. L. Burrell and three associates in mid-1947. They mined in some of the old surface pits, and worked underground on the 100-foot level. In 1952 their operations were centered around the Kelly workings where the adit was about 200 feet long. They drove a raise to the surface and found good ore in

Table 4. Guadalupe quicksilver mine, history and production record.

Year	Flasks	Average price per flask	Value	Historical remarks
Pre-1846				Cinnabar used as paint by Indians.
1846				Discovered by Josiah Belden.
1856				Extensive operations by Santa Clara Mining Association.
Pre-1875	20,000	$54.89	$1,097,800	Estimated production.
1875	3,342	84.15	281,229	First recorded production; mine sold to Guadalupe Mining Co.
1876	7,381	44.00	324,764	
1877	6,241	37.30	232,784	
1878	9,072	32.90	298,469	
1879	15,540	29.85	463,869	
1880	6,670	31.00	206,770	
1881	5,228	29.83	155,951	
1882	1,138	28.23	32,126	
1883	84	28.75	2,415	
1884	1,179	30.50	35,960	
1885	35	30.75	1,076	Mining operations suspended.
1886-1900	0		0	No production. Mine in litigation.
1901	960	48.46	46,522	Century Mining Co. began producing.
1902	764	43.20	33,005	
1903	800	42.25	33,800	
1904	609	37.62	22,911	
1905	300	35.94	10,782	
1906	311	36.50	11,352	
1907-1908	0		0	Company reorganized.
1909	1,777	47.71	84,781	New Guadalupe Mining Co. began producing.
1910	2,400	45.23	108,552	
1911	5,000	46.01	230,050	
1912	6,100	42.04	256,444	
1913	1,413	40.23	56,845	
1914	1,000	49.05	49,050	
1915	2,910	81.52	237,223	
1916	1,569	93.50	146,702	
1917	3,100	98.29	304,699	Concentration plant of 50-ton capacity installed.
1918	1,476	114.03	168,308	
1919	616	89.03	46,477	
1920	342	75.45	25,804	
1921	0	44.56	0	
1922	48	55.35	2,657	
1923-1929	0		0	No production. Litigation.
1930, 1932-1934, 1936-1937	192		13,941	No production in 1931 and 1935.
1938	50	69.55	3,478	Mine operated by Laco Mining Co. on mine ore.
1939	121	98.43	11,910	Mostly mine ore.
1940	262	169.77	44,480	
1941	210	176.03	36,966	Mine and dump ore.
1942	200	184.58	36,916	Trenching, sampling, drilling by U. S. Bur. Mines.
1943	267	181.96	48,583	
1944	411	113.14	46,501	Modern rotary furnace installed.
1945	705	128.08	90,296	About 20 percent dump ore.
1946	965	92.61	89,367	
1947	299 (1947-1951)	83.74	30,397 (1947-1951)	Operations terminated.
1948		76.49		
1949		79.46		Small-scale operations on dump ore and underground.
1950		81.26		
1951		210.13		
Totals	110,087		$5,462,012	

Source of statistics:
1856-1937 { 35th Report State Mineralogist, 1939. California Div. Mines Bull. 139.
1938-1946—U. S. Bur. Mines, Rept. Inv. 4682, 1950.
1947-1951—Estimated.

the iron-stained silica-carbonate rock. The ore was treated in a battery of nine butane-fired, Rossi-type, tile-lined retorts. Each retort was about 1 by 7 feet in size and was rated with a capacity of 2 tons of ore per day.

New Almaden Mine (New Almaden Dumps, Senator, Enriquita, Santa Clara, Chaboya). Location: About 10 miles south of San Jose in secs. 1, 2, 3, 4, T. 9 S., R. 1 E., and secs. 27, 28, 29, 33, 34, 35, T. 8 S., R. 1 E., M. D. (projected). Ownership: Sexton Estate, 444 W. Chestnut Avenue, Chestnut Hill, Philadelphia 18, Pa.; leased to Cordero Mining Company, 57 Post Street, San Francisco.

The geology of the New Almaden mine has been described by numerous investigators (Whitney 1865, p. 68; Goodyear, 1882, p. 112; Becker, 1888, pp. 310-330, 467; Forstner, 1903, pp. 168-171; Schuette, 1931) for over 88 years. As surface and underground mapping progressed it became possible to formulate a more complete picture of the ore deposits and their genesis. One of the most recent accounts was prepared by Bailey (1951) whom we quote in part as follows:

> Most of the rocks that comprise the mineralized belt along which lie the New Almaden mines are members of the heterogeneous Franciscan group, of Jurassic (?) age. These rocks have been intruded by sill-like bodies of serpentine that are only slightly younger in age. Parts of the intrusives, notably their margins, have been further altered at a much later time by hot waters to form silica-carbonate rock, which is the host rock for all of the sizeable ore bodies.
>
> The rocks of the Franciscan group include large amounts of graywacke, some arkose and shale, and a little conglomerate, limestone, and chert; it also includes a variety of surficial mafic igneous rocks which, because of their altered character, are generally classed as greenstones. Along the mineral belt these greenstones are partly lavas, including some pillow lavas, but tuffs and breccias predominate. Included with the very slightly metamorphosed rocks of the Franciscan group are other metamorphic rocks that are largely recrystallized and in many places coarsely crystalline. Most of these more strongly metamorphosed rocks contain a considerable quantity of at least one of several metamorphic minerals, such as glaucophane, crocidolite, or hornblende, which are generally absent in the normal rocks of the group.
>
> In the eastern part of Los Capitancillos Ridge explored by the New Almaden mine the major structure is a northwest-trending anticline, or up-arched fold, whose southwest limb is puckered and sheared along a bordering major shear zone. The crest of the anticline is close to the apex of the ridge, and the trend, although somewhat irregular, is roughly the same as that of the ridge.
>
> Two major sills of serpentine, which converge near the crest of the anticline, were intruded up the north limb, across the crest, and down the southern flank for a short distance. Where these sills join near the crest they also appear to have broken through to levels higher than even the present land surface, and to have put out other thin tongues downward along the sides of the fold. The larger and deeper ore bodies of the New Almaden mine were formed along the margins of the two major sills, but the ore bodies nearer the surface were formed along the narrower tongues of serpentine.
>
> The anticline trends northwestward several miles to the vicinity of the Enriquita mine, where it is cut off obliquely by a fault which trends more to the north than the anticlinal axis. The effect of this fault is to offset northward the part of the anticline that lies to the west of the fault, with the result that the Senator and Guadalupe mines although along the northwestward projection of the axis, actually are in the southwest limb of the fold. The northeast limb in this area has been dropped downward by a major west-trending fault and is entirely covered by younger rocks.
>
> The ore mineral of real economic importance was cinnabar, although locally native mercury impregnated and enriched the ores. Accompanying sulfides, present in only small quantities, included pyrite, stibnite, chalcopyrite, sphalerite, galena, and bornite. Gangue minerals that were introduced with the cinnabar were dominantly quartz and dolomite with some hydrocarbons.

The cinnabar that forms the ore bodies occurs chiefly as a replacement of the silica-carbonate rock along steep northeast-trending fractures. The replacement extended only a few inches out from the fractures, but within this limit was so complete that commonly over 50 percent of the replaced rock was cinnabar. In many of the large ore bodies the steep fractures occurred as swarms so closely spaced that much of the intervening silica-carbonate rock was rich ore.

Nearly all the ore bodies were formed in silica-carbonate rock, although this rock occupies only a small part of the district. Further, only that part of the silica-carbonate rock close to the contacts with rocks of the Franciscan group was particularly favorable for ore deposition, and most of the ore bodies were richest within a few feet of these contacts. Where the contacts were steep, the swarms of the northeast-trending fractures were a dominant factor in localizing ore bodies. Along the more gently inclined contacts the ore bodies tended to form at the crests of domes or plunging anticlines.

The field relationships and the relict textures of the rock leave no room for doubting that the silica-carbonate rock formed from serpentine through a process of replacement. Analyses of the parent serpentine and the derived silica-carbonate rock of the New Almaden area indicate that the principal change in the rock has been a simple substitution of carbon dioxide for water, resulting in a rock composed of a fairly definite proportion of quartz and magnesite. This type of silica-carbonate rock probably is widespread in the Coast Ranges. The time of the hydrothermal alteration of the serpentine to silica-carbonate rock is indicated to be at least as late as middle Miocene, and therefore the altering solutions can hardly be related to either the serpentine or its parent magma.

The quicksilver ore bodies are believed to have been deposited during the Pliocene epoch by hydrothermal solutions rising from a deep-seated source. This source probably is the same magma chamber that gave rise, in upper Miocene time, to intrusives and flows of rhyolite and dacite in the New Almaden area. The exact chemical character of these solutions cannot be determined, but they are commonly supposed to have been alkaline.

The rising solutions followed fractures that were best developed in the silica-carbonate rock near the contact with rocks of the Franciscan group. They deposited cinnabar in an interval extending from near the present surface to a depth of about 2,600 feet, and in a temperature range believed to have been between 50° and 125° C. Rich ore bodies were formed where a spreading-out and stagnation of the solutions was caused by structural traps formed by a capping of relatively impervious sheared rocks of the Franciscan group; but along steep contacts replacement from solutions flowing through fractures was extensive enough to form ore bodies even where structural traps were absent.

Most of the ore bodies that have been mined were both large and exceptionally rich. The largest was about 200 feet wide, 15 feet thick, and extended down the dip for about 1,500 feet. Although the workings at New Almaden extended to a depth of 2,450 feet below the surface, most of the production was made above the 800-foot level.

The original discovery of cinnabar at New Almaden is lost in antiquity. Its presence on Mine Hill was known to the oldest Indians of the district as a source of paint for tribe ceremonials. It was also used in bartering with visiting tribes from the Pacific Northwest. An account of ancient Indian mine workings was quoted by Heizer and Treganza (1944, pp. 311-312):

> Long ere gold was discovered in California, the Padres and early settlers knew of a cavern in the hillside, about a mile and a half from the present village. [It] proved to be in length one hundred feet running into the mountain horizontally. No one ever thought it was an artificial excavation of great antiquity . . . . [After discovery of cinnabar] the original opening [was] widened [in] clearing away the rubble and dirt at the end of the cave. Several skeletons were discovered, together with crude mining tools and other curious relics, clearly proving it an old excavation made by the natives for the purpose of securing vermillion, so much used by all savages to paint themselves. The position of the skeletons in the rubbish covering them left no doubt that having followed the vein of cinnabar without exercising due precaution to prop the loose ground overhead they had been literally buried alive in a grave of their own making [Lord 1866, vol. 1, pp. 209-210].

The mine was rediscovered in 1824 by Antonio Suñol and Luis Chaboya, who thought cinnabar was an ore of silver; during the succeeding 10 years unsuccessful attempts were made to recover that metal.

In 1845 Andres Castillero, a Mexican army officer, recognized cinnabar as the source of quicksilver. He claimed the mine and changed its name from Chaboya to Santa Clara. Under his supervision the ore was retorted in gun barrels and whalers pots and 2000 pounds of quicksilver was produced in 1846.

Castillero returned to Mexico and leased the mine to Barron, Forbes & Company, who immediately changed its name to New Almaden after the fabulous quicksilver mine at Almaden, Spain. The grade of ore treated in 1850 ran 36.74 percent, and 7,723 flasks of quicksilver was produced.

Much of our early information on the mine and its operation is found in the letters of travelers to their eastern correspondents. One early account of ore treatment by a batch process (Lyman, 1848) mentioned a furnace of four kettles, supported by "adobies," connected to masonry condensers. Each kettle was loaded with 400 pounds of apple-sized lump ore, covered, and luted with sand. Fire was applied during the day, withdrawn at night, and the metal (200 to 300 pounds of quicksilver) recovered from the condensers on the following morning. It was stated that the recovery "was a much less percentage than the assay indicated." Shortly thereafter some ore was mixed with lime and burned in a lime kiln with greater recovery. Six miners were employed.

By 1852 the mine workings were estimated to total over a mile in length, and were described by Hart (1853, p. 139) as follows:

> The tunnel is about 900 feet in length, 10 feet wide, and 10 feet high, with a railroad extending the entire length. The tunnel is some 300 feet below the former outlet near the top of the mountain. We were now each furnished with a torch.
>
> We soon commenced our exploration from chamber to chamber, which appeared to extend in a most intricate manner in almost every direction. Sometimes we descended a pole almost perpendicular for 50 feet, with merely little notches cut for the toes.

In 1854 (p. 438) Blake stated:

> The cinnabar is brought down [to the reduction works] on [a train of] mules that carry about 200 pounds each, and make two trips a day.
>
> The mining is principally performed by Mexicans and by Yaqui Indians. One or two Cornishmen had recently commenced work.
>
> The drilling is done with long heavy drills and the hammer is not used.

In a few years (1857) the length of the tunnel had been doubled (Browne, 1865):

> The main entrance to the mine is a tunnel [which has] already been carried to the distance of 1800 feet. Through this an iron rail track passes the cars receiving the ore as it is brought upon the backs of carriers (lanateros) from the excavations. These cars are calculated to carry about a ton each, and are pushed rapidly in and out by hand 600 feet below the level of the mountains. About 300 persons are employed in the mine. The lanateros are most muscular and the best proportioned of all those engaged at the mine. Long practice has inured them to the labor, and a first rate man will pack 200 pounds up the escalaros without stopping to rest. A large sack or panner of hide, open at the top, is slung to the back, and supported by a strap passing over the shoulders and around the forehead. The whole weight is then supported by the muscles of the neck. An efficient lanatero will make from 20 to 30 trips a day.
>
> After being deposited by lanateros into cars, it is brought out on the railroad to the line of sheds. Here it is deposited in heaps and attacked by a gang

of assorters whose business is to separate the fine from the coarse ore. The latter is broken in pieces suitable to the furnace and after being cleared of all rock and earthy matter is carted below [to the Hacienda or lower works]. The former, in the shape of siftings, is converted into bricks or cakes for use in construction of building at the Hacienda.

Entering the works we find a row of 16 furnaces ranged side by side. They stand some 8 feet apart, and are 4 feet in length, 10 feet in height, and 8 feet in width.

The ore, after being thoroughly cleaned and broken to the required size, is wheeled in barrows from the pile where it was deposited, along the top of the furnaces and turned into the receptacles, which are of uniform capacity and open at the top. These will contain about 7 tons of ore each. As the ore becomes sublimated, the vapors pass through a series of 12 compartments, entering the one nearest the fire from the top, the second from the bottom, and so on alternately. In their passage through the compartment, such of the vapors as become condensed flow in the form of quicksilver through numerous small holes into covered troughs, attached to the outside of the furnace their entire length, through which the metal is conducted to an iron vat, the size of a half hogshead, sunken into the ground. The flasks are filled and carted to the embarcadero at Alviso, and sent thence to San Francisco where they are exported chiefly to Mexico and South America.

A dispute over land titles in the vicinity of the mine culminated in an injunction against the operating company in 1858. Mining was suspended between October 1858 and January 1861. In September 1863 the property was sold to the Quicksilver Mining Company for an arbitrated price of $1,750,000.

The peak of production at New Almaden was reached in 1865 when a total of 47,194 flasks were produced. Much of the shallow, low-cost bonanza ore had now been mined and the grade of ore had fallen to 12.42 percent.

The next 8 years was a period of declining production. In 1874 production dropped to 9,084 flasks, and the grade of all ore treated was 2.96 percent. In order to supply the furnaces it became increasingly necessary to treat a larger proportion of tierras, or fine ore. Old dumps were reworked and washed, providing additional fines. Over two-thirds of the total mine production was now in this class. These fines were mixed with clay and sun-dried to form briquets or adobes. In this form furnace roasting was possible, but the cost of treatment was increased 95¢ per ton. The problem of low-cost coarse-ore treatment was solved in 1874 by successfully introducing a continuous furnace developed in Germany to burn lime.

The factors affecting the predominance of fine-ore production, however, led toward the development of an improved metallurgical method at New Almaden which was of world-wide significance. After a period of experimentation and redesign, the Scott-Huttner continuous fine-ore furnace was patented in 1876. Its capacity was about 25 tons per 24 hours. The details of this furnace were described by Christy (1885). This furnace solved the problem of fine-ore treatment at New Almaden, and, coupled with a successful underground exploration program, initiated a new 13-year period of prosperity for the mine.

It gradually became apparent that ore bodies were being depleted at a rate exceeding that of new discoveries. Production slumped in 1889, and the mine was beset by falling fortunes from which it never fully recovered. The Quicksilver Mining Company was declared bankrupt in 1912, and in 1914 production fell to the lowest point in the history of the mine, 949 flasks.

The present owners acquired the property in 1915. The mine was revived under the stimulus of high quicksilver prices during World War I. The old furnaces were torn down and quicksilver remaining in them and in the underlying ground was recovered. Underground operations were resumed at the Senator workings 4 miles northwest of Mine Hill. Here a Herreshoff furnace was installed and a 90-ton Scott fine-ore furnace was built. These operations were described by Huguenin and Castello (1920, pp. 213-224). Operations continued successfully until 1926, but in 1927 the 77-year record of continuous quicksilver production was broken.

The old mine dumps were worked intermittently by various lessees between 1928 and 1939 (Franke, 1930, pp. 29-31) and the quicksilver was recovered in retorts.

Civil strife in Spain during the late thirties and the imminence of war in Europe resulted in another rapid rise in the price of quicksilver. Consequently in 1940 the New Almaden Corporation was formed to lease and exploit the mine.

Old dumps and filled-in near-surface stopes on Mine Hill were worked by open-cut methods. A moderate tonnage of good ore was found at the top of an uncompleted stope covered by a surface dump. New ore was also mined in open cuts.

Underground work was also begun to permit mining above the 800-foot level. The Day tunnel was reopened for 3,600 feet and the two-compartment Santa Rita shaft was rehabilitated to a point 725 feet below the surface. Many of the old workings were drained and rendered accessible. An 80-foot headframe was erected and a 150-horsepower single-drum hoist carrying a $2\frac{1}{2}$-ton skip was installed.

A modern 5- by 60-foot rotary furnace rated at 100 tons per day was installed near the south slope of Mine Hill to treat the ore. It was accompanied by ore bins, 10- by 16-inch Blake jaw crusher, a Sirocco dust collector, exhaust fans, and a condensing system and stack. The average grade of ore treated ran three-tenths of one percent. Details of the operation were described by Huttl (1943).

Since ore reserves at New Almaden were almost nonexistant, the management requested the U. S. Bureau of Mines to examine the property with the hope that new discoveries might be made. In 1943 the U. S. Bureau of Mines and the U. S. Geological Survey embarked upon a diamond-drilling program with a two-fold purpose: First, to search for undiscovered ore above the 800 level, and second, to develop information that might give a clue to ore genesis and serve as a guide to prospecting.

This project was encouraged by the long production record of the mine and by the fact that nearly half its production was obtained from rich ore above the 800 level. A total of 6,807 feet of hole was diamond drilled but no new ore was found. The planning and execution of the diamond-drill program has been described in three reports (Sayers, 1943; 1945; Bedford and Ricker, 1950).

The operations of the New Almaden Corporation on Mine Hill continued until the end of World War II in 1945. The rotary furnace was removed during the following year.

A deposit of cinnabar gravel overlain by a dump of furnace calcines was uncovered in 1945 near the site of the old treatment plant at the

FIGURE 4. Diamond-drilling rig exploring for cinnabar on the southeast slope of Los Capitancillos Ridge, New Almaden quicksilver mine.

foot of Mine Hill. The cinnabar gravel, discovered in a test pit, overlay the Franciscan bedrock, and was itself overlain by 15 to 20 feet of nearly barren gravel. Furnace discharge dumps were exposed in the upper part of the pit. The cinnabar gravel ranged from half an inch to 8 inches in size, was well rounded, and extremely high grade. The cinnabar content was about 75 percent, the remainder being unreplaced silica-carbonate rock.

This part of the property was purchased and operated by H. L. Austin and C. L. Thomas. The deposit was mined with a dragline. The calcines and barren gravel were cast over and the pay-streak gravels were loaded to a 5-ton truck for processing in a nearby electrically operated washing plant consisting of a grizzly, a trommel screen, a picking belt for 1-inch oversize cinnabar gravel, sluice boxes with Hungarian riffles and two Pan American jigs for undersize gravel

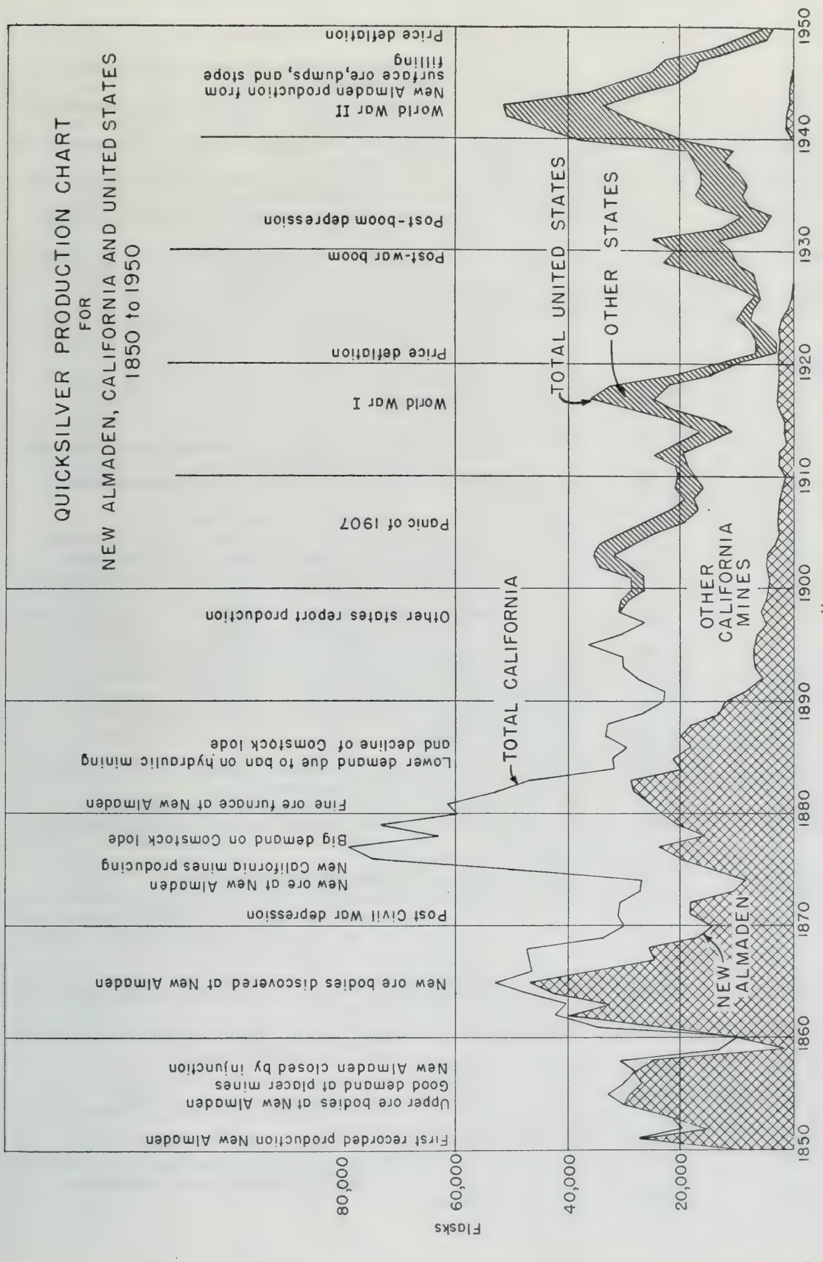

QUICKSILVER PRODUCTION CHART
FOR
NEW ALMADEN, CALIFORNIA AND UNITED STATES
1850 to 1950
First recorded production New Almaden
Upper ore bodies at New Almaden
Good demand at placer mines
New Almaden closed by injunction
New ore bodies discovered at New Almaden
Post Civil War depression
New ore at New Almaden
New California mines producing
Big demand on Comstock lode
Fine ore furnace at New Almaden
Lower demand due to ban on hydraulic mining
and decline of Comstock lode
Other states report production
Panic of 1907
World War I
Price deflation
Post-war boom
Post-boom depression
World War II
New Almaden production from
surface ore, dumps, and stope
filling
Price deflation
TOTAL CALIFORNIA
TOTAL UNITED STATES
OTHER STATES
OTHER CALIFORNIA MINES
NEW ALMADEN
Flasks
80,000
60,000
40,000
20,000
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
Years

FIGURE 5.

Table 5. New Almaden quicksilver mine, history and production record.

Year	Flasks	Average price per flask	Value	Historical remarks
Pre-1800				Cinnabar pigment used, mined, traded by Indians.
1824				Rediscovered by Chaboya, who attempted to recover silver.
1835				Second unsuccessful attempt to recover silver from ore.
1845				Mine claimed by Castillero who proved it contained quicksilver.
1846	26	$100.00	$2,600	Small recovery, using gun barrels and whaler's pots.
1847-1849	?	?	?	Leased to Barron-Forbes, improved furnaces, no production record.
1850	7,723	99.45	768,052	First recorded production.
1851	27,779	66.93	1,859,248	Board of Land Commissioners set up to arbitrate land disputes; adit driven on 300-ft. level.
1852	15,901	58.33	927,505	
1853	22,284	55.45	1,235,648	
1854	30,004	55.45	1,663,722	
1855	29,142	53.55	1,560,554	
1856	27,138	51.65	1,401,678	
1857	28,204	48.73	1,374,381	Day adit begun, to ventilate and drain mine above 600-ft. level.
1858	25,761	48.83	1,257,910	Castillero's title voided. Mining stopped by injunction.
1859	1,294	61.13	79,102	Enriqueta workings opened.
1860	7,061	53.55	378,117	Use of retorts abandoned, except for testing.
1861	34,429	42.05	447,739	Court decision appealed. Mining resumed.
1862	39,671	36.35	1,442,041	Appeal denied by U. S. Supreme Court; marshal ordered to seize property.
1863	32,803	42.08	1,380,350	Property sold to Quicksilver Mining Co., after international arbitration.
1964	42,489	45.90	1,950,245	Cora Blanca ore body discovered.
1865	47,194	45.90	2,166,205	Peak production year; North Ardilla ore body discovered.
1866	35,150	53.13	1,867,520	Santa Rita flat ore bodies discovered.
1867	24,461	45.90	1,122,760	
1868	25,628	45.90	1,176,325	
1869	16,898	45.90	775,618	San Francisco shaft sunk from 300 to 600-ft. level; new ore.
1870	14,423	57.38	827,592	J. B. Randol appointed general manager.
1871	18,568	63.10	1,171,641	Began sinking first shaft (Randol single-hoist shaft).
1872	18,574	65.93	1,224,584	
1873	11,042	80.33	887,004	Mining down to 900-ft. level.
1874	9,084	105.18	955,455	Randol shaft reached 1100-ft. level; crosscut found new ore; New World ore body discovered 600-800 ft. levels; continuous coarse-ore furnace introduced.
1875	13,648	84.15	1,148,479	
1876	20,549	44.00	904,156	Scott-Huttner fine-ore furnace patented; Grey shaft sunk.
1877	23,996	37.30	895,051	Began sinking Santa Isabel 3-compartment shaft for drainage and ore.
1878	15,852	32.90	521,531	
1879	20,514	29.85	612,343	
1880	23,465	31.00	727,415	Completion of furnace plant for fine-ore treatment.
1881	26,060	29.83	777,370	
1882	28,071	28.23	792,444	Began sinking Buena Vista shaft (reached 2300-ft. level); Washington shaft completed.
1883	29,000	28.75	833,750	

Table 5. New Almaden quicksilver mine, history and production record.—Continued

Year	Flasks	Average price per flask	Value	Historical remarks
1884	20,000	$30.50	$610,000	
1885	21,400	30.75	658,050	Began sinking America shaft.
1886	18,000	35.60	640,800	
1887	20,000	42.38	847,600	
1888	18,000	42.50	765,000	Began sinking St. George shaft; America shaft abandoned; prospecting from Washington shaft abandoned.
1889	13,100	45.00	589,500	J. B. Randol retired.
1890	12,000	52.50	630,000	
1891	8,200	45.25	371,050	
1892(?)	5,563	40.71	226,470	
1893	6,614	36.75	243,065	
1894	7,235	30.70	222,115	Drifting and sinking to April 30, totaled over 65 miles.
1895	7,050	37.04	261,132	
1896	6,200	34.96	216,752	
1897	4,700	37.28	175,216	
1898	5,875	38.23	224,601	
1899	4,435	47.70	211,549	
1900	4,610	44.94	207,173	
1901	4,260	48.46	206,440	
1902	4,835	43.20	208,872	
1903	4,770	42.25	201,533	Mine worked on 1000-ft. level through Harry and Victoria shafts; mine flooded below 1300-ft. level.
1904	3,280	37.62	123,394	
1905	2,388	35.94	85,824	
1906	2,881	36.50	105,157	
1907	2,310	38.16	88,150	
1908	2,240	42.33	94,819	
1909	1,920	47.71	91,603	
1910	1,638	45.23	74,087	
1911	2,533	46.01	116,543	
1912	2,595	42.04	109,094	Quicksilver Mining Company declared bankrupt.
1913	994	40.23	39,989	
1914	1,400	49.05	68,670	
1915	1,470	81.52	119,834	Property leased for 25 years by G. H. Sexton.
1916	2,447	93.50	228,795	Herreshoff multiple rabble furnace installed at Senator.
1917	2,821	98.29	277,276	Concentration by table and flotation attempted and abandoned.
1918	2,501	114.03	285,189	Scott 90-ton furnace built at Senator.
1919	2,396	89.04	213,340	
1920	2,551	75.45	192,473	
1921	2,709	44.56	120,713	
1922	2,314	55.35	128,080	
1923	2,681	60.98	163,487	
1924	2,147	68.33	146,705	
1925	973	80.81	78,628	
1926	3	87.64	263	Mine closed.
1927	0	111.67	0	No production reported for first time in 77 years.
1928		118.84		
1929		117.78		
1930		110.36		
1931		83.22		
1932	1,231	52.30	128,922	Production from dump ore; retorted.
1933		55.94		
1934		67.22		
1935		67.23		
1936		76.62		

Table 5. New Almaden quicksilver mine, history and production record.—Continued

Year	Flasks	Average price per flask	Value	Historical remarks
1937		$83.82		
1938		69.55		
1939		98.43		
1940		169.77		Property leased to New Almaden Corp. (C. N. Schuette).
1941		176.03		Modern rotary furnace in operation on surface ore.
1942		184.58		Day tunnel and Santa Rita shaft reopened.
1943		181.96		Diamond drilling underground by U. S. Bur. Mines.
	9,888		$1,518,873	
1944		113.14		Operations impeded by wartime labor shortage.
1945		128.08		Cinnabar gravel discovered under calcine dump.
1946		92.61		Modern rotary furnace removed.
1947		83.74		Continued work on gravel; washing plant and retort.
1948		76.49		U. S. Geological Survey study reported.
1949		79.46		Lessee working surface and dumps, retorting ore.
1950		81.26		Outbreak of Korean war.
1951		210.13		Property leased to Cordero Mining Co.; exploration drilling. Project completed in 1953; no ore found.
Totals	1,051,041	----------	$49,436,161	

Source of statistics:
1850-1937 { 35th Rept. State Mineralogist; California Div. Mines Bull. 139.
1938-1951—Compiled by California Div. Mines.

(minus $\frac{3}{8}$-inch and minus 1-inch, respectively). The concentrate was burned in an oil-fired D-retort. The retort pan charge consisted of 200 pounds of cinnabar gravel and 60 pounds of lime to oxidize the sulfur in the ore. This operation, which continued into 1947, was described by Bailey and Everhart (1947).

The U. S. Geological Survey war-program of strategic mineral investigation included detailed geological mapping of the New Almaden area. The resulting geologic maps, covering over 10 miles of accessible workings above the 850-foot level, were placed in open file in 1948. In addition, a map and report describing several areas in the mine which offered greatest promise for further exploration at minimum cost were published (Bailey, 1952).

The Defense Minerals Administration was formed to facilitate exploration for strategic minerals following the outbreak of the Korean war in June 1950. On August 6, 1951, the DMA announced the approval and signing of a contract with the Cordero Mining Company for exploration of the New Almaden mine. The exploration program called for 10,000 feet of diamond drilling to test the structures outlined by Bailey (1952). Surface drilling began in September 1951 and was completed by November 1952. No new ore was found.

Meanwhile, underground crews were busy reopening the 800-foot level Day Tunnel through fractured and caving serpentine. By January 1953 the tunnel was open for a distance of about 3,000 feet and underground diamond drilling, sponsored by the DMA, was again under way. The project was completed about May 1953. No new ore was found.

Nonmetallic Mineral Commodities

Cement

Cementing material was used in the pyramids of the ancient Egyptians as a binder for the blocks of limestone forming those structures. The Greeks and the Romans employed volcanic tuff and ash, calcined by the heat of the crater, as the cementing material in their structural works. During the Roman period the ash was originally obtained from Mt. Vesuvius near the town of Pozzuoli, and similar binders are still known as puzzolans or puzzolan cement. No further progress was made in the development of cement-making until 1756.

In that year John Smeaton, an English engineer, recognized that some impure limestones harden under water after calcination. In 1824 Joseph Aspidin, an English mason, patented his method of making Portland cement. The cement received its name from its resemblance to a widely used structural limestone quarried on the Island of Portland.

Portland cement was first manufactured in the United States in 1871, near Coplay, Pennsylvania. The first continuous rotary kiln for cement-making was employed in 1899. Rapid expansion of the Portland cement industry since that time has been a result of the demonstrated usefulness of its product.

Portland cement is made by combining rocks containing calcium carbonate with rocks containing the oxides of aluminum, silicon, and iron. Limestone is the principal source of the calcium carbonate. Other sources include cement rock (limestone containing clay in suitable proportions); chalk (a fine-grained limestone composed of microscopic foraminifera shells); travertine (a banded calcium carbonate deposited around hot springs); shell deposits; and chemically precipitated calcium carbonate from industrial processes. Clay or shale are the usual sources of aluminum oxide (alumina) and silicon dioxide (silica). Slate or blast-furnace slag may also be used. Quartz or chert present in limestone as impurities may furnish part of the required silica. Very often, however, they are present in excessive quantities and are considered deleterious material. Since magnesium oxide (magnesia) is an undesirable constituent in cement, limestone containing impurities above 2 or 3 percent in the form of magnesia is unsuitable for cement-making. Dolomitic limestone (containing 5-25 percent magnesium carbonate) and dolomite (containing 25-45 percent magnesium carbonate) cannot be used. The iron oxide is often provided by a laterite or high-iron clay. Iron ore or pyrite calcine may also be the source of this ingredient (Bogue, 1947).

Permanente Cement Company. Location: Permanente, California, about 3 miles west of Monta Vista.

Construction of the Permanente cement plant (named after Permanente Creek, a flowing stream discovered by the Spaniards) began in June 1939. The first barrel of cement was produced on Christmas Day of the same year. The original output of the plant (7,000 barrels per day) was destined for the construction of Shasta Dam, keystone of the United States government's Central Valley Project in California. A total of 6,800,000 barrels of cement were used in constructing Shasta Dam, largest overflow dam in the world.

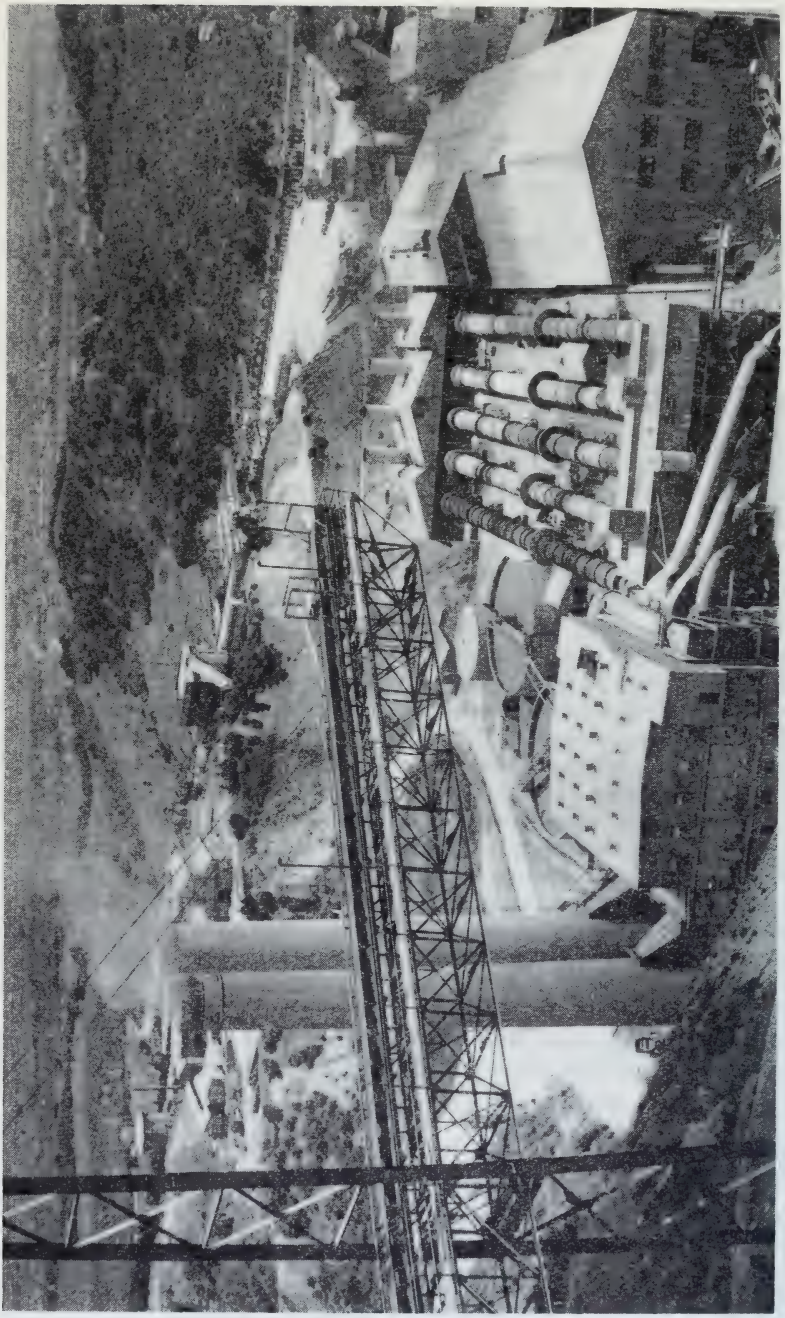


FIGURE 6. Aerial photograph of cement plant of the Permanente Cement Company. The fifth rotary kiln was placed in operation during 1951. *Photo by courtesy of Permanente Cement Company.*

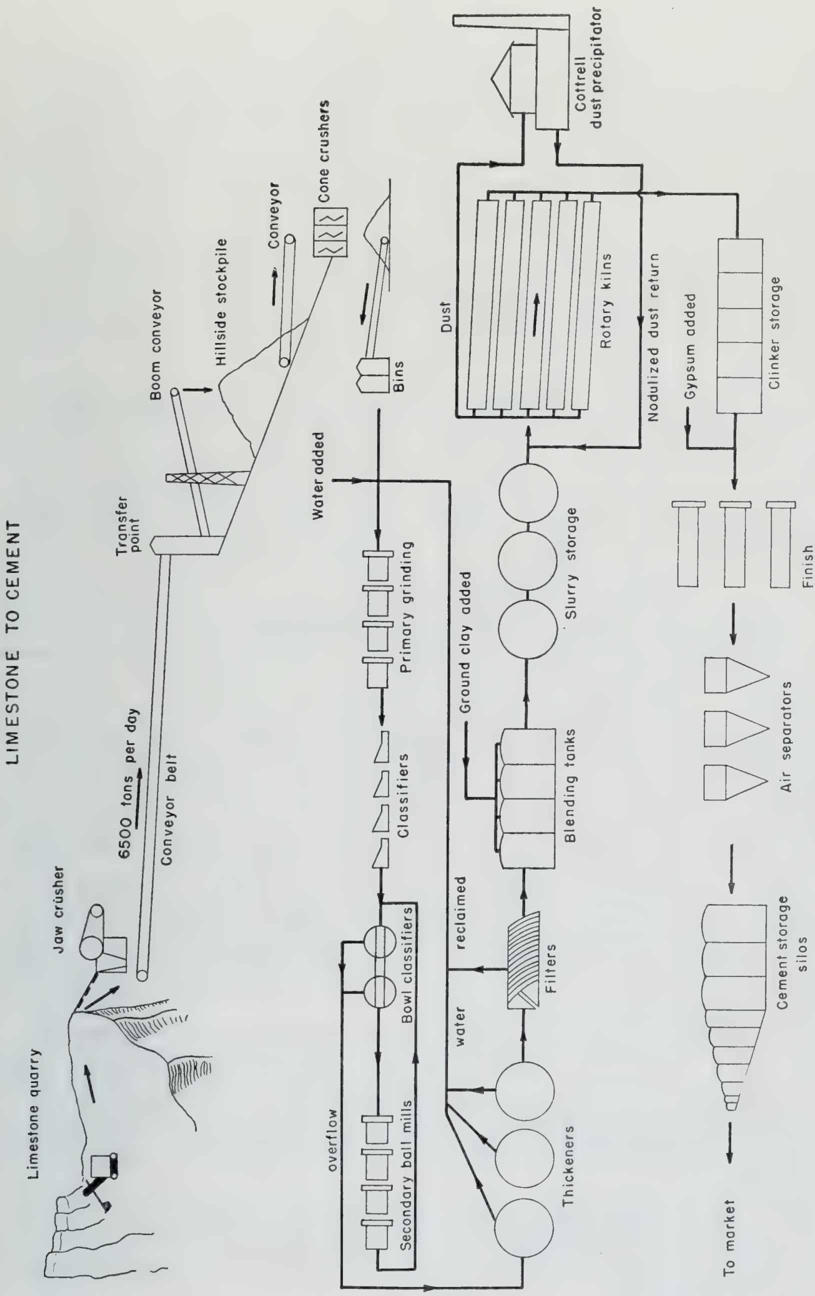


FIGURE 7. Flowsheet, limestone to cement.

The original design of the Permanente wet-process plant included two 12- by 363-foot kilns, three primary ball mills, one rake classifier, two 150-foot thickeners, two tube mills, and four finish mills.

A third kiln was installed in 1940 to supply installations of the U. S. Navy in the Pacific defense area. The kiln was supplemented by a Symons 5-foot cone crusher, two secondary ball mills with bowl-classifier circuits, Oliver filters, and two finish mills ($9\frac{1}{2}$ by 10 feet and 8 by 40 feet in size). Details of the plant at that time when capacity had been increased to 12,000 barrels per day were presented in Pit and Quarry (1943).

A fourth kiln was added in July 1941 as prospective federal government needs mounted with the imminence of war. Another $9\frac{1}{2}$- by 10-foot ball mill in closed circuit, a 10- by 125-foot slurry thickener, a hammer mill for clay grinding, and a finish mill unit were added at this time. Rated capacity reached 16,000 barrels of cement per day after making these improvements.

New clinker cooler installations were begun on the kilns in 1946 and completed in 1947. These additions raised the capacity of the kilns and brought the latter units into balance with finish grinding capacity. Changes were also made in the raw grinding section to meet the demands of the kilns. These changes, raising the output to $5\frac{1}{2}$ million barrels per year, were described in detail by Jack (1948).

A fifth kiln, 12 by 448 feet in size, was put in operation in March 1951. An 8- by 39-foot Smidth tube mill and $9\frac{1}{2}$- by 10-foot ball mill were added to the raw grinding circuit. Similar ball and tube mills were added to the finish grinding circuit. Finished cement storage capacity was also increased.

The kiln dust collected in the Cottrell precipitator was formerly pug-milled with kiln feed slurry and re-introduced to each kiln. This practice resulted in increased fuel consumption and had irregular effects on clinker composition. To correct these conditions it was decided to nodulize the dust with a clay slurry and introduce it into a single kiln where it provides 50 percent of the feed. This installation, completed in 1951, was designed to handle 1000 tons of dust per 24-hour day. It has resulted in a 6 percent overall fuel saving, a 3 percent increase in kiln capacity, a decreased dust load in the kilns and in the Cottrell precipitator, a decrease in time lost, and a decrease in dust disposal horsepower. The nodulizing process was recently described in considerable detail by Hass (1952).

All five types of A.S.T.M. specification cement are made at this plant. Over 31,000 connected horsepower are required for operation, and natural gas is consumed at the rate of 20,000 M.C.F. per day. The rated output is now 7 million barrels of cement per year, making Permanente the largest cement plant in the world. Over 425 men are employed in its operation.

A generalized flow sheet of the plant is shown in figure 7. The deposits of source materials used in the manufacture of cement by the Permanente Cement Company are described in the clay and limestone sections of this report.

Clay and Ceramics

Clay is composed of hydrous aluminum silicate minerals, derived from the weathering of rocks. It can be worked into a plastic mass

when tempered with water. Although there are many types of clay, the clay minerals can be divided into three major mineralogic groups: kaolinite, montmorillonite, and illite. The clay produced in Santa Clara County belongs to the complex illite group of minerals. The illites have the general formula $(Al_4Fe_4Mg_4Mg_6)Ky(OH_4)(Al_ySi_{8-y})$.

Illite is widely distributed as a constituent of soils and marine shales. Deposits of illitic clay can also be found in valley fill and along the flood plains of streams and rivers; they are usually found in sediments designated on geologic maps as Quaternary alluvium.

Santa Clara County clays are ordinarily used in the manufacture of common brick, tile, sewer pipe, and earthenware. They contain a sufficient amount of sand to prevent excessive shrinkage during firing and enough iron oxide to cause vitrification at a relatively low firing temperature. The most productive deposits are located near industrial centers, as the low "in place" value of this commodity cannot support high transportation charges to the point of manufacture.

Common clay was used locally in Santa Clara County during the period of Spanish colonization in the 18th Century. Adobe brick and fired roofing tile were both made from clays found in the vicinity of San Jose (Egenhoff, 1952). Very little tile was made during the three decades following the close of the Mission period in 1832 and demand during that interval was satisfied almost entirely by salvaging from abandoned buildings. The increase in population during and after the gold rush, however, created extensive demand for clay products. Consequently one of the first brick plants in the county was established in 1863 and production has been almost continuous since that date. The principal clay pits in Santa Clara County are along the banks of Coyote Creek, Los Gatos Creek, and Guadalupe Creek.

Clay is an important ingredient in the manufacture of cement for it provides the necessary supply of iron, alumina, and silica. Nearly every cement plant has an adjoining clay pit. Near the Permanente Cement Company limestone quarry, clay is obtained from a weathered layer of andesite or basalt, interbedded with the sedimentary rocks.

Garden City Pottery Company. Location: Plant, 560 North 6th Street, San Jose; pit, about 3 miles north of San Jose at intersection of Coyote Creek and Highway 17, in sec. 29, T. 6 S., R. 1 E., M. D., projected. Ownership: Garden City Pottery Co.; L. C. Rossi, superintendent.

The company was established in 1904. At present the plant is divided into two parts, one devoted to the manufacture of flower pots, and the other to stoneware and gardenware.

For making flower pots, local clay obtained from the above-mentioned pit is blended with sand and Lincoln clay. The ratio of these materials is about 50 percent, 30 percent, and 20 percent, respectively. Stiff mud is prepared in an auger machine and extruded as a solid cylinder or pug. The size of the pug depends upon the size of the pot being made. For instance, a pug about 4 inches in diameter and 16 inches long is used for 10-inch pots. The pug is passed through a portable wire cutting machine dividing the cylinder lengthwise into five parts. Each small cylinder is then given a kerosene bath and placed in an automatic pot press.

The pressed pots are placed on shelves on a slow-motion mechanical conveyor and passed through a waste-heat dryer above some of the kilns. The ware passes four times through the dryer and is then ready for firing.

Firing requires about 30 hours and is done in Hoffman continuous kilns at a temperature of 1800°-2000° F. Production amounts to about 20,000 flower pots per day.

Stoneware is made from Lincoln clay exclusively. The mix is prepared by grinding, washing, filtering, and pugging. It is then hand-shaped on potter's wheels and dried in steam-heated drying rooms for 3 to 4 days. The ware is then glazed and fired. Firing is done in beehive and rectangular periodic kilns at a temperature of about 2200° F. Various types of rabbit feeders, chicken feeders, crocks, water coolers, and colored garden ware are manufactured.

Gladding Bros. Manufacturing Company (Kartschoke Clay Products Company, Peterson-Kartschoke Brick Company, Petersons Brickyard). Location: Plant at 3rd and Keyes Streets, San Jose; clay pit on Coyote Creek about a mile east of plant, approximately in sec. 15, T. 7 S., R. 1 E., M.D. projected. Ownership: Gladding Bros. Manufacturing Company; Charles Gladding, president; A. C. Gladding, secretary.

A brick plant was established at this locality in 1868. Since that time a succession of owners have expanded the plant and converted it to manufacture a wider range of products. The present owners acquired the company in 1929. The list of products now includes roofing tile, vitrified clay pipe (sewer pipe), and clay flue lining.

Common clay is obtained locally from a 4-acre pit on the east bank of Coyote Creek, south of Storey Road. The clay is light brown in color and contains some silt. The pit has a maximum diameter of about 200 feet and a maximum depth of about 30 feet. The deepest part of the pit is in the southeast corner where a trench 40 by 60 feet has been excavated. Two upper benches have banks of 5 and 12 feet respectively. There is no overburden. The clay is mined with power equipment and trucked to the plant. About 40 percent local clay is used in the products of this plant which are manufactured by the stiff-mud process.

Local clay, Ione clay, Lincoln clay, and waste pipe are collected in a batch car and ground in a dry-pan. Roofing tile and 4-inch sewer pipe are formed by an auger machine. Flue lining and sewer pipe in the 6- to 24-inch range are formed in a steam sewer-pipe press.

The drying is done in sheds or drying rooms and is completed in 10 days. Live steam, exhaust steam, and waste heat are the drying agents.

Firing is done in periodic kilns. Five round, down-draft kilns about 25 feet in diameter, and eight rectangular kilns are available for this purpose. The latter have been rebuilt from a Hoffman continuous, common-brick kiln. Setting, firing, cooling, and withdrawing require from 10 to 14 days, depending on the size of the product. The maximum firing temperature is about 2000° F. Temperature is controlled by use of both pyrometer and firing cones. The former control the initial heating period; the end points are determined by cones.

Plant capacity is 15,000 tons per year of fired product, which is delivered in company-owned trucks. Seventy men are employed at the plant.

Handcraft Tile Company (San Jose Tile Company). Location: One and a half miles south of Milpitas on the east side of Highway 17. Ownership: Lloyd Janic, Route 6, Box 281, San Jose.

Red and white clays from Lincoln are blended with common clay from Irvington to manufacture rectangular, hexagonal, and octagonal floor and wall tile. Waste tile or grog is ground in a hammer mill and added to the raw clay. This gives the tile greater strength, and decreases its shrinkage and tendency to warp. The entire mix is tempered in a pug mill and hand-worked in plaster of Paris molds which absorb the moisture.

After a 40- to 60-minute period the casts are removed from the molds, placed on pallets, spray-colored, and sent to a 10- by 20-foot gas dryer where they remain for 1 day. The tile is then transferred to a 4- by 5- by 60-foot continuous kiln for firing. The tile remains in the kiln for 2 days where a temperature of 2170° F. is attained.

Upon removal from the kiln the tile is buffed to bring out the color. The unsprayed clay-mix burns to a natural terra cotta (orange) color. The tile is also made in a series of antique colors. Five men are employed.

Permanente Clay Deposit. Location: sec. 17, T. 7 S., R. 2 W., M. D. Ownership: Permanente Cement Company, Permanente.

Shale or clay often provides the aluminum, iron, and silica required for making cement. At this locality clay is derived from the weathering of a body of andesite or basalt and is obtained from a mountain spur between the Permanente limestone quarry and the cement plant. The andesite has some of the characteristics of a flow, yet its uniform thickness over a considerable distance suggests that it may be an intrusive body. It is found between the ''Light'' and the ''Blue'' limestone units. A typical chemical analysis shows: silica 56.5 percent, alumina 19.0 percent, ferric iron oxide 12.5 percent, lime 5.7 percent, and magnesia 4.1 percent.

The clay is mined by bulldozers and diesel-powered Le Tourneau carryalls at the rate of 1,000 tons per day. The carryalls dump their load to a 36-inch conveyor belt leading to the clay stockpile on the hillslope above the cement plant. The clay is pulverized in a hammer mill, a ball mill, and tube mills before it enters the blending tanks at the cement plant.

The local sources of clay are supplemented by the use of laterite or high-iron clay from Ione (Amador County); and iron oxide in the form of pyrite calcine obtained from chemical plants in the San Francisco Bay area.

Remillard-Dandini Company. Location: On east bank of Coyote Creek, north of Storey Road. In secs. 15, 16, T. 7 S., R. 1 E., M. D., projected. Ownership: Remillard-Dandini Company; W. S. Stanley, president; 321-13th Street, Oakland; Joe Feasal, plant superintendent.

This plant was established in 1863. Local light-brown clay is used exclusively to make brick by the soft mud or molded process. The clay pit is about a quarter of a mile in diameter and has been excavated to a depth of 25 feet. Clay is mined by a Lorrain gasoline shovel equipped with a ½-yard bucket. Rails are laid to the face of the pit and the shovel loads directly to 4-yard cars hauled by a Plymouth gasoline engine.

The clay is delivered to receiving bins, drops to an auger where water is added, and passes to the brick molds. Molded bricks are conveyed to pallets and placed in outdoor drying sheds where they remain for a 2-week period (during the summer season).

The firing is done in an oval-shaped Hoffman continuous kiln, fired with pulverized coal introduced through vents in the roof of the kiln. The firing cycle occupies about 15 days and the maximum temperature attained is about 1800° F. The average production is 10,000,000 bricks per year. The plant employs 45 men.

San Jose Brick and Tile Company (San Jose Brick Company). Location: Near the west branch of Los Gatos Creek at 1916 Fruitdale Road; in the SW¼ sec. 24, T. 7 S., R. 1 W., M. D. Ownership: San Jose Brick and Tile Company, 1440 Broadway, Oakland; W. S. Stanley, president; J. F. Dair, plant superintendent.

This plant was established in 1868 and is one of the oldest operating plants in the state. Local light-brown clay obtained from an extensive L-shaped pit adjoining the plant was used until 1951 when it no longer was economically feasible to mine. Since then crude clay has been obtained from a pit on Coyote Creek adjoining the Remillard-Dandini plant.

Clay from the pit is delivered to an inclined field conveyor belt leading to the dry-grinding pan. After grinding and screening, the clay is delivered to a longitudinal storage shed for seasoning until used.

The crude clay is made into brick by the stiff mud process. This involves tempering the clay with water in a pug-mill, making the clay more plastic by removal of entrained air in a Freese de-airing machine, extruding the de-aired clay through a die as a continuous ribbon, and cutting the ribbon of clay into sizes suitable for bricks with a wire

FIGURE 8. Mechanized loading of rectangular field kiln with yard-dried brick at plant of the San Jose Brick and Tile Company.

cutting machine. The newly formed bricks are removed to an open-air drying yard where they remain for a week or longer depending upon the season of the year.

Firing is done in a sectionized Hoffman oval-shaped down-draft, continuous kiln with 16 loading doors. Oil is used as fuel during the initial heating period. When the brick charge is hot the burners are turned off and pulverized coal introduced through vents in the roof of the kiln. The hot brick ignites the coal, the coal fires the brick, and the temperature reaches 1800° to 1900° F. The complete kiln cycle of loading, firing, cooling, and unloading requires 15 days.

A field kiln is also used during the summer season. This kiln is about 160 feet long, 20 feet high, and 40 feet wide, with sidewalls about 5 feet thick. This kiln is loaded with lift trucks, fired entirely with oil, and has a kiln cycle of 10 days. Brick-making and field-firing are not done during the winter months, but burning continues the year round in the Hoffman kiln using brick made during the dry season.

Production averages 16 million bricks per year and 40 men are employed. A brick crushing house provides brick fragments for roofing granules.

Limestone

Limestone is composed chiefly of the mineral calcite (calcium carbonate, $CaCO_3$). Most limestones are impure; the impurities include magnesium carbonate (dolomite, $MgCO_3$); silica, SiO_2 (as quartz or chert); iron oxide, Fe_2O_3; clay (aluminum silicate); or organic matter. Travertine is a variety of limestone deposited from solution by groundwater or springs.

Limestone is extensively used in chemical and manufacturing industries, in cement, in metallurgy, in agriculture, in the building industry, and in road construction. Many of these uses have been described in publications of this Division (Ballou, 1951; Bowles and Jensen, 1949; Logan, 1947, pp. 180-200).

Occurrences of limestone have been noted from Santa Clara County in rocks ranging from Jurassic to Recent in age (Logan, 1947, pp. 310-317). The only production of commercial limestone, however, has been made from a member of the Jurassic (?) Franciscan formation. These limestone beds were named Calera limestone by Lawson (1914) who originally studied them at Calera Hill, near Rockaway Beach, San Mateo County. Discontinuous outcrops of limestone similar to the Calera in the Franciscan formation can be traced southeastward into Santa Clara County along the west side of the Santa Clara Valley as far south as Gilroy. These outcrops follow the trend of the San Andreas and associated faults through the area. Some geologists have considered the Calera limestone to be discontinuous faulted segments (Walker, 1950). Quarries have been opened and production has been made in Santa Clara County at the following localities: Permanente Creek near Black Mountin, southeast of Los Gatos, near the Guadalupe mine, in the Santa Teresa Hills, and in the hills southwest of Gilroy. The limestone is a fine-grained, high-lime rock, much of which is interbedded with, or contains lenses of, chert. The presence and distribution of the chert usually governs the method of quarrying, and hence determines the commercial value of the particular deposit.

The occurrence of small limestone lenses in sedimentary rocks of Tertiary age have been noted by Crittenden (1951) and Gilbert (1943). These lenses are found on the east side of the Santa Clara Valley. No commercial production has been reported.

A deposit of travertine of Recent age in the southwestern part of the county has been described by Allen (1946, pp. 47, 72) who stated:

> A tributary to Hatfield Canyon has built up its bed for over half a mile with travertine terraces. The lime-rich waters are derived from a series of small springs which are aligned in a northwesterly direction in the headwaters of the tributary. The terraces consist of cemented boulders and blocks of sandstone at at the base, overlain by alternating pools and falls whose lips are made up of buff to gray travertine.

Allen also mentions the production of a small tonnage of Franciscan limestone from the area north of La Brea creek.

Bernal Marl and Limestone Deposit. Location: On the southeast side of the Santa Teresa Hills, 3½ miles southeast of Edenvale on Highway 101, and 1½ miles southwest of the highway; in sec. 19, T. 8 S., R. 2 E., M. D., projected.

A hard, fine-grained, gray limestone with a low easterly dip crops out over a vertical distance of about 200 feet at this locality. A typical exposure shows 2 feet of soil and 4 feet of soft marl overlying hard limestone. The thickness of the marl varies in the quarry workings where it is exposed in a number of irregular benches 20 to 30 feet high.

Marl for agricultural use has been produced here intermittently since 1915. The last reported production was made in 1938 and a California Department of Agriculture analysis of the product tested a 79.2 percent calcium carbonate equivalent. Some production of hard limestone for use in the beet sugar industry was made about 30 years ago.

Douglass Ranch Limestone Deposit. Location: About 2½ miles southeast of Los Gatos on Quarry Road at an elevation of about 1,000 feet; in SW¼ NW¼ sec. 27, T. 8 S., R. 1 W., M. D.

Light-gray, fine-grained limestone is exposed over a vertical distance of 100 feet and a horizontal distance of about 200 feet. The quarry consists of two benches, each about 35 feet high. A 12-foot bed of limestone is exposed in the lower face near road level. This bed contains some secondary layers and lenses of brown and white calcite. Black chert is also present. The limestone is in contact with Franciscan sandstone near the top of the quarry and dips from 22° to 35° S.

Lyndon Limestone Deposit. Location: About 1 mile due south of Los Gatos on the north side of Limekiln Canyon in sec. 28, T. 8 S., R. 1 W., M. D.

Old quarry workings now overgrown with brush extend over a small area. Calera-type limestone is exposed in one face about 10 feet high. It consists of alternating beds of light-colored limestone and black chert ranging from half an inch to 3 inches in thickness.

Permanente Limestone Deposit (Black Mountain Limestone Deposits, Santa Clara Holding Company, El Dorado Sugar Company Quarry, Alameda Sugar Company Quarry). Location: The quarry is about 4 miles west of Monta Vista on the north side of Permanente Creek in

SE$\frac{1}{4}$ sec. 18 and the SW$\frac{1}{4}$ sec. 17, T. 7 S., R. 2 W., M. D. The company holdings also include property in secs. 16 to 21, T. 7 S., R. 2 W., and in sec. 24, T. 8 S., R. 3 W., M. D. Ownership: Permanente Cement Company, Permanente.

The presence of limestone deposits on the slopes of Black Mountain has been known for many years and the production of high-grade selectively mined limestone for use in the sugar industry began about 1902 (Aubury, 1906). Early production was at the rate of 30 to 60 tons per day during the dry season. It was stated that the limestone contained black chert, shale, and clay, and that the waste from these impurities caused extra expense in quarrying the rock. Production for this usage continued intermittently until 1934.

The Permanente Cement Company began working the deposits in 1939 and gradually increased the production of limestone to about 6,500 tons per day in 1952. The cement company continued to supply the sugar industry with high-lime rock for a number of years and a low-level quarry was opened for this purpose in 1941. Low-grade rock from this quarry was sold as crushed stone. This practice was discontinued as the output of the cement plant expanded and its requirements for limestone increased.

The geology at the Permanente quarry and other quarries to the northwest has been described in a recent report by C. W. Walker (1950), as follows:

> The limestone apparently is in one stratigraphic zone which is divided lithologically into at least two units. The upper unit is light buff to gray and locally has been named the "Upper Light" limestone. The unit stratigraphically beneath the light limestone is dark blue gray to black and is referred to locally as the "Blue" limestone.
>
> The "Upper Light" limestone is light gray and contains numerous well-defined chert lenses and beds which form darker bands on weathered surfaces. Most of the limestone between the layers of chert is very finely crystalline and contains some foraminiferal remains. The beds, which range in thickness from 3 to 18 inches, have not been deformed as intensely as those of the "Blue" limestone; however, near faults the "Upper Light" limestone has been considerably drag-folded and crumpled. Average $CaCO_3$ content of "Upper Light" limestone at Permanente is 70.8 percent.
>
> The "Blue" limestone has beds ranging in thickness from 1 inch to 8 inches, and the unit varies in lithology from the base to the top. Near the base finely crystalline limestone beds are intercalated with abundant chert lenses and layers. Upward the number of chert lenses diminish, and locally the top 15 or 20 feet is relatively free of siliceous material. The upper limestone beds in this sequence are medium to coarsely crystalline. Interbedded in the "Blue" limestone are layers of laminated tuffaceous debris a few inches to a few feet thick, and at many outcrops bedding-plane shearing has caused complex intermingling of tuffaceous fragments with fragments of oxidized and altered greenstone and sandstone. Weathered surfaces throughout the sequence are gray, whereas freshly broken surfaces are dark gray to black. A distinct petroleum-like odor is noticeable on freshly fractured surfaces, particularly in the upper part of the "Blue" limestone sequence. Locally, along bedding planes and near cross faults, the limestone is brecciated and the fragments are recemented by caliches and other carbonate material. In some places, incomplete recementation of the breccia has resulted in porous, spongelike masses of limestone. The "Blue" limestone is highly deformed and fractured and prominent drag folds occur near all but the smaller faults.
>
> Locally solutions have filled cavities with large calcite crystals and have introduced finely crystalline carbonate material into numerous fractures and joints. Solutions have also introduced silica which has replaced the limestone near larger chert lenses.
>
> The "Upper Light" limestone and the "Blue" limestone are very similar in chemical composition. Silica, in the form of chert lenses, is the most important

impurity in both units; other adulterating materials are present in negligible quantities. The percentage of SiO_2 varies not only from outcrop to outcrop within the belt, but also from one stratigraphic horizon to another within the limestone units. Limestone beds between layers of chert have a calcium carbonate content as great as 97 percent. Small quantities of MgO, SiO_2, Al_2O_3, and Fe_2O_3 are the only impurities. The "Blue" limestone generally contains a higher ratio of $CaCO_3$ to SiO_2 than the "Upper Light" limestone. The purest beds are near the top of the "Blue" limestone where chert lenses are scarce or absent.

A light limestone unit appears stratigraphically below the ''Blue'' limestone at Permanente and was formerly termed ''Lower Light.'' Current studies, however, have supported the belief that ''Upper Light'' and ''Lower Light'' are the same unit separated by an east-dipping, low-angle thrust fault. Consequently the terms ''Upper Light'' and ''Lower Light'' are no longer used.

The limestone quarry is about 1½ miles west of the cement plant at an elevation of 1,525 feet. The horseshoe-shaped quarry face is about 150 feet high. The rock is intensely fractured. Churn drills formerly used were replaced in 1951 by an electrically operated Joy rotary blast-hole drill which in 8 hours can drill 300 feet of smooth-walled hole 7⅜ inches in diameter. Cartridge loading can thus be used, resulting in improved fragmentation.

''The Joy Rotary drill is also used in the exploratory work being carried on at the plant. A 'split stream' sampler is mounted on the drill and samples obtained at intervals of ten feet. Sampling is even carried on in the blast holes giving some quality control of the variable limestone.'' [1]

Broken stone is loaded by a 5-yard Bucyrus-Erie electric power shovel into diesel-powered Caterpillar-Le Tourneau rubber-tired buggies of 20-ton capacity. The load is transported about a quarter of a mile to the edge of the quarry floor where the 8-inch grizzly and the 56- by 72-inch Buchanan jaw crusher are located. Secondary size reduction is made in a 4½-foot Telesmith gyratory crusher. The minus 3-inch product is discharged directly to a 48-inch-wide conveyor belt which carries it at the rate of 1,000 tons per hour to the transfer house about a mile away. Here, the rock is dropped to down-slope storage piles adjoining the cement plant. After further reduction to minus ⅜-inch size in two 5-foot and one 4-foot Symons cone crushers, the limestone enters the cement raw grinding circuit.

Lime

Lime, calcium oxide (CaO), is formed as a result of heating limestone ($CaCO_3$), to a temperature at which the carbon dioxide (CO_2) is removed as a gas. Lime manufacturing is an ancient industry and lime is widely used in the building trades, in agriculture, and in numerous chemical processes (Bowles and others, 1941).

Although the Spanish padres may have produced lime during the Mission period, the first commercial lime on record in Santa Clara County was produced in a kiln near the Guadalupe mine about 1864 (Irelan, 1888, pp. 543-546). The Guadalupe limestone quarries and kiln were active for about 30 years.

Limestone was quarried southeast of Los Gatos as early as 1886 and was burned in kilns at that city. Lime was also produced on a small

[1] Covello, A., Permanente Cement Company, personal communication.

scale in other parts of the county from 1908 to 1913. No lime production has been reported since that date.

An extensive deposit of oyster and clam shells in the southern part of San Francisco Bay has supplied neighboring industrial plants with a low-cost raw material of high lime content for many years. The use of these shells in the production of commercial lime for the magnesia industry was described by Seaton (1942). He stated that higher than normal lime-burning temperatures were required to process the shells, and that the calcining should be done in a basic-lined kiln.

A plant at Alviso now dredges and processes shells for the poultry industry. (See *Mineral Processing*).

Magnesite

Pure magnesite, magnesium carbonate ($MgCO_3$), is chemically equivalent to magnesia (MgO), plus carbon dioxide (CO_2). Magnesite can be broken down into these components when heated or calcined in a kiln at high temperature. The resultant magnesia is used chiefly as a refractory lining for steel and other metallurgical furnaces. Magnesia has also a wide variety of industrial applications such as in the manufacture of building and insulation materials, oxychloride cement, chemicals, and magnesium metal.

During the period 1905 to 1935 magnesia was produced chiefly by the calcination of crude magnesite from California mines. About 1936 chemical plants for the production of low-cost magnesia from sea water were established on a commercial scale. Large massive deposits of magnesite which could be mined by low-cost surface methods were also brought into production in other states. The high-cost underground mines in California no longer were able to supply magnesia on a competitive basis, and crude magnesite production in California fell to a comparatively low figure except for a temporary revival during World War II, 1941-45.

The occurrence of magnesite at two widely separated localities in Santa Clara County was known as early as 1885 (Hanks, 1886). No attempt was made to develop the deposits for many years owing to the uncertainty of a market for magnesite.

In 1887 work began on the Cochrane deposit in the foothills along the east side of the Santa Clara Valley, 3 miles east of Madrone. A small production of magnesite was made from this and other deposits in the vicinity. Although these deposits are favorably situated with respect to rail transportation, they appear to be small in size and low in grade. In general, production from this area has been small.

The principal magnesite deposits are in the Red Mountain district, T. 6 S., R. 5 E., M. D., 31 miles southeast of the railroad shipping point at Livermore. A short description of the minerals at Red Mountain (Bodenlos, 1951) and a detailed report on the mineral deposits (Bodenlos, 1950) have been published by this Division.

Rocks of the Jurassic (?) Franciscan formation crop out in the Red Mountain district. The sedimentary beds include arkosic sandstone, shale, and chert. The Franciscan formation also includes a tabular body of basic igneous rock which has intruded the sedimentary rocks along the bedding planes. The intrusive is complex and contains several basic rocks including peridotite, dunite partly altered to serpentine, pyroxenite, and gabbro. These rocks are composed chiefly of silicate min-

erals containing magnesium, iron, and some calcium. When these minerals weather and the iron changes to oxides under the action of surface agencies, a red soil results; from this soil color Red Mountain derives its name.

Post-intrusive fracturing developed two systems of shear zones, one striking northwest and the other striking north. The former system dips northeast and consists of long, straight, narrow breaks; the latter system consists of short, wide, irregular breaks with variable dips. The intrusive rock in the sheared areas was subsequently altered to serpentine by ascending waters.

The magnesite-bearing solutions ascended from a deep-seated source at a still later period. Moving through the fractured zones they deposited magnesite as veins. The north-trending, wide shear zones provided the most favorable localities for mineral deposition. Minerals other than magnesite, including dolomite, chalcedony, opal, calcite, magnesium silicates and dendritic manganese oxide, were also deposited.

The magnesite deposits range from 100 to 900 feet in length, 1 to 35 feet in width, and about 700 feet in depth from the surface. Stockworks of magnesite, containing a high percentage of impurities in the form of country rock, approach 125 feet in width.

Western Mine. Location: About 31 miles southeast of Livermore in secs. 18, 19, T. 6 S., R. 5 E., M. D. Ownership: Westvaco Chemical Division, Food Machinery and Chemical Corporation, Newark, California.

Development work began here in 1899; the first shipments of magnesite were made in 1905 by the American Magnesite Company. Hess (1908) visited the property at that time and stated:

> A number of veins occur in a group around a small valley, so arranged as to be excellently located for working by adits and an aerial tram. Only one vein on the Alameda claim, near the top of the ridge, was being worked. . . . Mining is carried on by means of an open cut, in which the magnesite is quarried and allowed to fall through an upraise to an adit below, whence it is moved in cars to the aerial tram. The tramway, rated at 100 tons per 10-hour day, drops 600 feet in the 2,500 feet to the bunkers. The skips are placed 500 feet apart and each carries 1,000 pounds of magnesite. . . . The magnesite is delivered to bunkers, from which it is loaded into wagons for hauling to Livermore.

In 1912 the Western Magnesite Development Company was organized to operate the patented and unpatented claims of the American Magnesite Company. Adjoining claims were located in 1915 by the Pacific Magnesite Company. Subsequent litigation involving these two companies resulted in the appointment of a receiver to operate the property in 1917 (Huguenin and Castello, 1920, p. 189). A legal settlement was made in 1919 and the property reverted to the Western Magnesite Company who leased the mine to C. S. Maltby. At that time 60 to 70 men were employed for 9 months of the year and production was at the rate of 30 tons per day. The high-grade coarse ore was hand-picked and calcined in vertical kilns, while the low-grade fines were shipped as crude ore.

By 1923 aerial trams were in operation from both the north and south workings (Bradley, 1925) and ore was being produced at the rate of 150-200 tons per day. The lump ore was calcined in four vertical kilns and the fine ore was calcined in a Scott quicksilver furnace.

FIGURE 9. Portals and dumps of the Western Magnesite mine, Red Mountain district.

An interesting account of the actual mining operations at the Western mine was presented by Palmer (1927) who stated in part:

In opening a deposit, a main entry is driven in the footwall parallel to the vein. These entries are 7 by 7 ft. in cross-section and require little timbering, as the unaltered serpentine is not materially affected by atmospheric agencies. At intervals of 150 to 200 ft. main raises are driven, with a cross-section of 5 by 7 ft. to the next level. These raises are carried in the footwall until they meet the vein, and this is then followed upward. Between the main raises, at intervals of 30 ft., secondary raises are carried up approximately 15 ft., at which level they have penetrated a few feet into the vein. They are then turned each way at angles of 45° and carried in the vein on this slope until they meet.

Stoping is then done by drilling holes in the back, and blasting down and drawing off only such ore as necessary to give working room. Occasional pillars are left to support the walls, but, with this exception the method is typical shrinkage stoping, and need not be described. Operations cease with a back from 6 to 8 ft. thick between the stope and the next level. This ore and the stope pillars will be removed when the time comes to abandon that part of the mine. Stoping is carried on by working upward from the main levels, driving a level in the vein to the end of the ore shoot and working backward until the ore is removed.

Main drifts, which have a cross-section of 7 by 7 ft. are driven with two miners and two muckers per shift. The men are paid $5.50 per shift, with a bonus of $1 per foot for every foot more than five broken per day. A standard center-cut round of from 12 to 15 holes is used, with about 50 lb. of powder per round. From 5 to 6 ft. per round is the usual progress. These drifts cost about $6 a foot.

The raises are 5 by 7 ft. in cross-section, and cost $4 a foot. Stoping is done by contract. The company furnishes the machines and air, sharpens the steel, and trams the ore; the contractor furnishes labor and powder only.

In 1931 the lease to the Western mine passed from C. L. Maltby to the California Chemical Corporation. The assets of the latter organization were purchased in 1937 by the Westvaco Chlorine Products Corporation. A change in mining methods was made about this time, reflect-

ing a change in the ore in the mine. Details of the revised mining and processing method were described briefly by Perry and Kurwan (1942, p. 35) as follows:

> Early mining consisted of open-cut and glory-hole work on the larger outcrops. This was followed underground by a modified shrinkage system, the waste and low-grade horses being removed by hand sorting on the tramming levels and transported to surface dumps. Filled-stope mining is used now, in order to eliminate the handling of waste, which has become more abundant as the smaller veins are being worked. This method is considered more efficient and as economical as the former method. Waste and ore are more easily separated on the stope floors than at tramming-level pockets. Grade of ore is held more uniform and waste tramming is eliminated. Cribbed ore chutes and manways are kept up to the level of the working floor. When veins produce insufficient waste, walls are shot down for stope filling.
>
> Three aerial trams are used to deliver the ore to the calcining plant. The difference of elevation between mine and plant is approximately 500 ft. and the longest tram is 3000 ft. Fines are removed from mine-run ore at the tramheads by $\frac{3}{4}$-in. screens protected by grizzlies.
>
> The stack kilns for burning caustic magnesite, described in earlier reports, were destroyed several years ago by fire that demolished the entire calcining plant. The new plant consists of crude and finished storage, crushing equipment, and a single rotary kiln, which is used only for making dead-burned ferromagnesite. The lining in the hot zone is 4-in. refractory brick; the remainder of the lining is high-silica firebrick. Crude oil is used as fuel, in a Simplex turbine burner. The kiln feed consists of crude magnesite crushed and rolled to minus $\frac{1}{2}$-in. mesh with enough iron added in the form of screened mill scale to give an iron content in the finished product of about 7.5 per cent. Approximately two tons of crude ore is required for each ton of dead-burned. The finished product is cooled on an inclined firebrick floor, which is divided into several sections that are used intermittently. After partial cooling, the material is drawn from the cooling floors into a bucket elevator that is in closed circuit with a $\frac{3}{8}$-in. vibrating screen and a small set of rolls. Material passing through the screen drops directly to steel silo storage from which it is transported by truck to Livermore for shipment.

Some production of magnesite was made from the Western mine each year from 1905 to 1945. Total production during that period approximated 870,000 tons. No production was reported in 1946. Production was resumed on a small scale in 1947. These operations were described by Honke after a visit to the property in 1948 [2] :

> The present production comes mainly from old dumps at the mine. Some hand sorting is done to improve the grade. The material removed is serpentine. The dump material is scraped to a hopper by a gasoline-powered scraper, is drawn into a 4-ton truck which hauls it to a bunker from which the highway trucks are loaded. The present production is trucked to Newark via Livermore in trucks of 13-ton capacity. About 3 hours are required for a one-way trip. The ore from this mine is generally low in lime, but in places is rather high in silica. The dump material is mixed at Newark with ore from Nevada to improve the magnesite-lime-silica ratio.
>
> The plant on the mine property for processing the magnesite is not being used. Large scale operations were suspended after the war, and since that time no appreciable mining has been done. Housing is available on the property, but the new housing constructed during the war has been removed. During the war about 70 to 80 men were employed on this property. One watchman-miner and one contract trucker are employed.

The name of the operating company was changed to Westvaco Chemical Corporation in 1948. Later in the year the company was taken over by the Food Machinery and Chemical Corporation, and has been operated as the Westvaco Chemical Division since that time.

Operating conditions remained unchanged in 1952.

[2] Honke, M. T., California Div. Mines, unpublished report, 1948.

Mineral Springs

Numerous mineral springs are found in the mountainous areas on both sides of the Santa Clara Valley. The waters from some of these springs were formerly developed commercially, but no production of mineral water from this county has been reported since 1932.

These springs have been described by Franke (1930, pp. 19-23) who also published tables of analyses of the waters and references.

Potash

Although potash is listed in the table of mineral production for the years 1919, 1920, and 1921, the product was the result of a manufacturing rather than a mining process. The Western Industries Company produced a potash fertilizer running 38 percent K_2O at their Agnew plant. The fertilizer was derived as a by-product from molasses distilleries.

Rock (Crushed)

Substantial quantities of crushed rock have been produced in the county for many years. Most of this material has been used in road construction, although a considerable quantity of fill rock has been required to meet the needs of the post World War II boom in the building construction industry. All rock types, igneous, sedimentary, and metamorphic, are included in the total production.

Along the east side of the Santa Clara Valley the following have been a source of road and fill rock:

1. *The Monterey formation of Miocene age.* This formation crops out in narrow discontinuous belts along the foothills and contains an appreciable thickness of alternating beds of chert and shale. The chert beds usually range from 1 inch to 3 inches in thickness, while the shaly layers are usually a fraction of an inch in thickness. The Monterey formation is so folded and distorted in places that cross fractures have developed in the chert normal to the bedding planes. In such places the chert breaks into small fragments when quarried. Substantial quantities of this chert are currently being mined. The distribution of the Monterey formation and the location of quarries is shown on maps prepared by Crittenden (1951).

2. *The Oakland conglomerate of Cretaceous age.* This formation is composed of pebbles, cobbles, and boulders cemented in a matrix of sand grains. It is generally hard and massive. Blasting is necessary to break the rock, and crushing may also be necessary for proper size reduction. This formation is being quarried near the mouth of Penitencia Creek.

Along the west side of the Santa Clara Valley the following have been a source of road and fill rock:

1. *The Santa Clara formation.* This is composed of loosely consolidated, poorly sorted conglomerate, sandstone, siltstone, and clay. The conglomerate members of the formation are quarried in the vicinity of the Stevens Creek Dam. Quarrying is done with power equipment and crushing is sometimes necessary to separate the sand matrix. Prelimi-

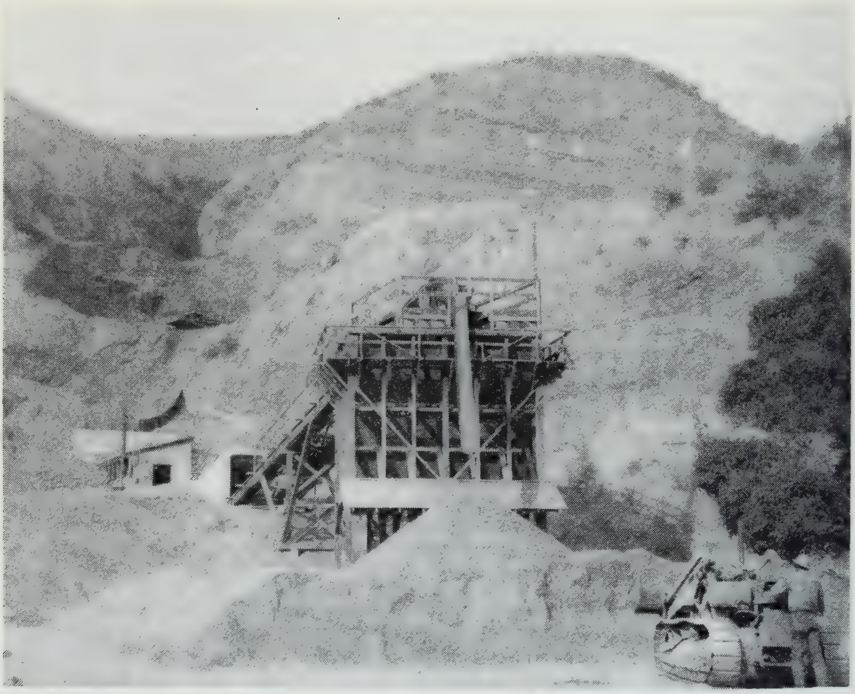


FIGURE 10. Voss quarry and plant near Stevens Creek Dam. Bulldozer delivers gravel from conglomerate member of Santa Clara formation to crushing plant.

nary blasting in place usually provides sufficient fragmentation for use of the material as fill rock without subsequent crushing.

2. *Basalt lava flows of Miocene age.* These have been quarried for many years at numerous points along upper Page Mill Road, west of the Stanford University campus. Unweathered basalt is a tough hard rock which breaks into equidimensional fragments very suitable for road rock. Quarrying in this district has diminished in recent years, owing to the gradual encroachment of residential development.

3. *Soft tan Purisima sandstone.* The sandstone overlies the basalt on the lower part of Page Mill Road, in the Stanford area.

4. *Rhyolite at Lone Hill.* About 5 miles northeast of Los Gatos, quarries were operated in 1952-53. The rhyolite was loosened with a rooter, and bulldozed to the crushing plant. The product was used in road construction.

5. *Franciscan sandstone of Jurassic (?) age.* A mile west of Saratoga, Franciscan sandstone is quarried by the county and crushed at the county plant. This locality has provided road rock since 1908.

6. *Mixture of shale and slickensided serpentine.* This rock is quarried for fill rock west of Mountain View.

7. *Furnace calcine from the Senator mine dump.* This was sold during 1952 under the name of "Almaden Slag." The material was loaded directly to trucks and used in driveways where it was said to make a firm, smooth, mudless surface.

Table 6. Rock (crushed) operations in Santa Clara County.

Map no.	Name	Location				Quarry opened	Status Nov. 1, 1952
		T.	R.	Sec.			
32	Anderson Lake	9S	3E*	10	Anderson Lake Dam	1950(?)	Idle
33	Bahr & Ledoyen	6S	3W*	26	Page Mill Road	1951	Active
34	Commercial Materials	7S	2W	22	Stevens Creek	1950(?)	Idle
35	County (Alum Rock)	6S	1E	23	Mouth Penitencia Creek	1950(?)	Active
36	County (Saratoga)	8S	2W	11	Mile west of Saratoga	1908	Active
37	Fredrickson-Watson (Winterbower)	6S	1E*	4	Los Coches Creek	1951(?)	Active
38	Lone Hill	8S	1E*	7, 18	Lone Hill	1952	Active
39	Piazza	6S	1E*	23	Mouth Penitencia Creek	1952	Active
40	Piazza	7S	2W	21 or 22	Stevens Creek Dam	1952	Active
41	Rhodes-Robinson (Stanford)	6S	3W*	23	Page Mill Road	Pre-1900(?)	Idle
42	Roggasch Bros.	6S	1E*	6	Story Road	1950(?)	Active
43	Senator Dump	8S	1E*	29	Seantor Mine	1952	Active
44	Sondgrath Bros. (Neary)	7S	2W*	6	West of Los Altos	1935	Active
45	Voss	7S	2W	28	Stevens Creek Road	1952	Active

* Mt. Diablo Base & Meridian projected.

Table 6. Rock (crushed) operations in Santa Clara County.—Continued

Map no.	Name	Type of deposit	Rock type (grab sample)	Operation size	Equipment used	Type excavation
32	Anderson	Metamorphic	Silicified serpentine	Moderate	(Removed)	Hillside
33	Bahr & Ledoyen	Contact	Silica-carbonate, serpentine, claystone	Moderate	Rooter and bulldozers (2)	Hillside
34	Commercial Materials	Conglomerate	Fine sandstone and shale	Moderate	(Removed)	Bank
35	County (Alum Rock)	Cemented conglomerate	Black chert, porphyry, quartzite	Small	Bulldozer	Hilltop
36	County (Saratoga)	Metamorphosed sediments	Quartzite	Large	Bulldozer	Hillside
37	Fredrickson-Watson	Folded sediments	Monterey chert	Large	Diesel shovel	Hillside
38	Lone Hill	Volcanic	Rhyolite	Small	Rooter-scarifier, bulldozer	Hilltop
39	Piazza	Conglomerate	Sandstone, siltstone, serpentine	Small	Bulldozer, loader	Hilltop
40	Piazza	Conglomerate	Chert, sandstone, shale	Small	Diesel shovel	Bank
41	Rhodes-Robinson (Stanford)	Volcanic flow and agglomerate	Basalt	Large	(Removed)	Hillside
42	Roggasch Bros.	Cemented conglomerate	Porphyry, chert, quartzite	Small	Rooter, bulldozer loader	Bank
43	Senator Dump	Furnace dump	Calcine	Small	Loader	
44	Sondgrath Bros. (Neary)	Contact	Serpentine and shale	Large	Rooter, bulldozer, carryalls (3)	Hilltop
45	Voss	Conglomerate	Shale, chert, sandstone	Small	Bulldozer	Bank

Table 6. Rock (crushed) operations in Santa Clara County.—Continued

Map no.	Name	Excavation size	Transport distance	Crushing equipment	Classification equipment
32	Anderson Lake	Semicircular, 200-ft. diameter, 100 ft. face	¼ mile	(Removed)	(Removed)
33	Bahr & Ledoyen	Cut 500 ft. wide, 50 ft. high, ¼ mi. long	¼ mile	Jaw	Portable plant, dry.
34	Commercial Materials	Face 175 ft. high, 400 ft. long	400 ft.	None	None
35	County (Alum Rock)	Face 75 ft. high, 700 ft. long	Load at face	None	None
36	County (Saratoga)	200 ft. high	¼ mile max.	Jaw	Screens, dry.
37	Fredrickson-Watson (Winterbower)	Face 150 ft. high, ¼ mi. long 500 ft. diameter	Load at face	None required	None
38	Lone Hill	500 ft. diameter	500 ft.	Jaw	Screens, dry
39	Piazza	Face 50 ft. high, 400 ft. long	Load at face	None	None
40	Piazza	25 ft. high	100 ft.	None	Loading bins
41	Rhodes-Robinson		¼ mile	(Removed)	(Removed)
42	Roggasch Bros.	Circular, 1000 ft. diameter, 50 ft. face	1000 ft. max.	Kue Ken jawcrusher	None. Belt to loading bins.
43	Senator Dump	Dump 30 ft. high, 20 ft. wide	Load at face	None required	None
44	Sondgrath Bros. (Neary)	500 ft. diameter	500 ft.	Jaw	Belt to loading bins.
45	Voss	200 ft. high	200 ft.	Gyratory	Trommel ahead of crusher, dry.

Table 6. Rock (crushed) operations in Santa Clara County.—Continued

Map No.	Name	Products	Rated capacity (per day)	Number of employees	Remarks
32	Anderson Lake	Rip rap and rock for dam			Tough massive rock
33	Bahr & Ledoyen	Crusher run base; State spec. sec. 21 rock; drain rock	800 tons	6	1½ in. rock to yard stockpile
34	Commercial Materials	Base and fill rock			
35	County (Alum Rock)	Road rock	200-300 tons	2	Bulldoze top and drop to loading level
36	County (Saratoga)	Unwashed road rock	1200-2000 tons	8–10	Oldest operating quarry in county
37	Fredrickson-Watson	Base rock	1500-2000 tons	2	Freeway base west of Milpitas
38	Lone Hill	Crusher run base	1000 tons	5?	Leveling hill for housing development
39	Piazza	Road rock	300-400 tons	3	Strip overburden with bulldozer
40	Piazza	Road rock	300-400 tons(?)	?	Installing loading bins
41	Rhodes-Robinson	Road rock			Shut down owing to encroachment of residential development
42	Roggasch Bros.	Road rock	500 tons (?)	4	Installing grizzly, crusher, bins
43	Senator Dump	Used as excavated	200 tons (?)	2	Driveway fill and base rock
44	Sondgarth Bros.	Fill rock and sub base	2500 tons	7	Prevents expansion of adobe under slab construction
45	Voss	Crusher run base	700 yds.	4	Santa Clara gravel with streaks of sand

Table 7. Sand and gravel operations in Santa Clara County.

Map. No.	Name	Location				Pit opened	Status Nov. 1, 1952
		T.	R.	Sec.			
46	Brem Bros.	11S	3E*	1	Carnadero Creek	1950(?)	Active
47	County (Gilroy)	11S	3E*	1	Carnadero Creek		Active
48	County (San Martin)	10S	3E*	11 or 12	Llagas Creek	1952(?)	Active
49	Los Gatos Construction	8S	1W*	16	Los Gatos Creek	1946	Active
50	Los Gatos Sand & Gravel	8S	1W*	15 or 16	Los Gatos Creek	Pre-1929	Active
51	Pacific Coast Aggregates	8S	2E*	26	Coyote Creek	1913	Idle
52	Piazza	8S	1E*	9	Guadalupe Creek		Active
53	Raische	7S	1E*	36	Coyote Creek	1946	Active
54	Smith, L. C., Co.	8S	1W*	16	Los Gatos Creek	1952	Active
55	Western Gravel (Doetsch)	8S	1W*	10	Los Gatos Creek	1940(?)	Idle
56	Western Gravel (PCA)	8S	1W	3	Los Gatos Creek	1912	Active
57	Western Tile & Supply	11S	3E*	2	Carnadero Creek	1946	Active

* Mt. Diablo Base & Meridian projected.

Table 7. Sand and gravel operations in Santa Clara County.—Continued

Map No.	Name	Type of deposit	Rock type (grab sample)	Size operation	Equipment used	Type excavation
46	Brem	Bed of intermittent creek	Red chert, fine- and medium-grained sandstone	Small	Diesel shovel	Pit
47	County (San Martin)		Sandstone, chert, serpentine	Small	Diesel shovel	Pit
48	County (Gilroy)		Red chert, sandstone	Small	Diesel shovel	Pit
49	Los Gatos Construction		Gabbro, volcanic rock, shale	Small	Bulldozer, loader	Pit
50	Los Gatos Sand & Gravel		Gabbro, volcanic rock, shale	Small	Diesel shovel	Pit
51	Pacific Coast Aggregate			Moderate	Removed	Pit
52	Piazza		Sandstone, chert, basalt, serpentine	Moderate	Dragline, shovel	Pit
53	Raische		Chert, sandstone, serpentine, quartz	Moderate	Rocker-shovel, 1¼ yd.	Pit
54	Smith, L. C., Co.		Granite, volcanic rock, shale	Small	Dragline	Pit
55	Western Gravel (Doetsch)		Sandstone, chert, volcanic rock	Small		Pit
56	Western Gravel (PCA)			Moderate	B. G. scraper	Pit
57	Western Tile & Supply			Moderate	Diesel shovel	Pit

Table 7. Sand and gravel operations in Santa Clara County.—Continued

Map no.	Name	Excavation size	Transport distance	Crushing equipment	Classification equipment
46	Brem Bros.	20 ft. deep	500 ft. max.	Jaw	Screens, chute, crusher, elevator return, washed
47	County (Gilroy)	20 ft. deep	None	None	None
48	County (San Martin)	30 ft. deep	None	None	None
49	Los Gatos Construction	50 ft. wide, 100 ft. long, 20 ft. deep	None	None	Load to trucks
50	Los Gatos Sand & Gravel	75 ft. wide, 100 ft. long, 30 ft. deep	¼ mi. max.	Jaw	Elevator, screens with spray, sand drag
51	Pacific Coast Aggregate	20 ft. deep	¼ mi.	(Removed)	(Removed)
52	Piazza	50 ft. wide, 30 ft. deep, ¼ mi. long	¼ mi.	Jaw and gyrosphere	Portable plant, dry
53	Raische	Pit ¼ mi. diameter, 15 ft. deep	¼ mi.	Jaw and rolls	Portable Cedar Rapids No. 1040, dry
54	Smith, L. C., Co.	20 ft. deep	None	None	Grizzly 45° over bin
55	Western Gravel (Doetsch)	100 ft. wide, 15 ft. deep, ¼ mi. long	2¼ mi.	Jaw	Vibrating screen with spray
56	Western Gravel (PCA)	½ mi. diameter, 20 ft. deep	1¼ mi.	Jaw	Vibrating screens with spray
57	Western Tile & Supply	¼ mi. wide, 30 ft. deep, ½ mi. long	¼ mi. or less	Jaw	Screens with spray

Table 7. Sand and gravel operations in Santa Clara County.—Continued

Map no.	Name	Products	Rated capacity	No. of employees	Remarks
46	Brem Bros.	1 in. and 2 in. washed gravel	200-300 tons per day?	3?	Steel construction
47	County (Gilroy)	Road rock	200 tons per day?	2	Intermittent operation
48	County (San Martin)	Road rock	200 tons per day?	2	Creek gravel
49	Los Gatos Construction	Base, fill, filter rock	40,000-60,000 yds. per year	2	Creek gravel
50	Los Gatos Sand & Gravel	Washed aggregate, sand	200-300 tons per day?	3-4	Plant of frame construction
51	Pacific Coast Aggregate	Plant removed	----------	----------	Site of minor operations
52	Piazza	Plus ¼ in. minus ¾ in.	800 tons per day?	4	Used for asphalt road aggregate
53	Raische	Plus ¼ in. minus ¾ in., sand	1000 yds. per day	8	Used for asphalt road aggregate
54	Smith, L. C., Co.	Base and fill rock	400 tons per day	3	
55	Western Gravel (Doetsch)	Washed aggregate, sand, pea gravel; dry crusher run base	800 tons per day	8	Wet weather pit; plant at No. 56
56	Western Gravel (PCA)	Washed aggregate, sand, pea gravel; dry crusher run base	800 tons per day	8	Dry weather pit
57	Western Tile & Supply	Washed aggregate and sand	300 tons per day	4	Gravel replenished during winter

Sand and Gravel

Unconsolidated granular material resulting from the natural disintegration of rocks, ranging in size from plus 200-mesh to minus $\frac{1}{4}$ inch, is classed as sand. Similar material ranging from plus $\frac{1}{4}$ inch to minus $3\frac{1}{2}$ inches in size is classed as gravel. Stream deposits are usually heterogeneous mixtures of these components. They may also include undersized fines and oversized cobbles and boulders. Stream deposits are poorly sorted, imperfectly stratified, and elongated in the direction of stream flow. Annual replenishment of these deposits is common in regions of adequate rainfall.

Sand and gravel have been important in the mineral production of Santa Clara County for many years. The value of the product has been ordinarily combined with crushed rock and listed under the heading "Miscellaneous stone" in statistical reports.

The principal use of sand and gravel is as an aggregate in concrete. Consequently, the deposits have been developed in the vicinity of the centers of population which are also the centers of building activity.

The chief sources of sand and gravel in Santa Clara County have been Coyote and Los Gatos Creeks. Smaller quantities have been produced from Guadalupe and Carnadero Creeks. Occasional production has been made from Llagas and Pacheco Creeks.

Since most of these creeks originate in the mountains on the flanks of the Santa Clara Valley, the gravels are composed chiefly of rock types common to the Franciscan formation. They include arkosic sandstone, chert, shale, basalt, gabbro, and quartz.

Draglines and power shovels are used to mine the deposits, most of which are worked only to shallow depths. Rock to be used in concrete aggregate is washed in small screening plants. Unwashed gravel is used for road and fill rock.

Serpentine

A moderate quantity of serpentine was mined at the quarry of Paul Houret near Almaden during 1946 and 1947. The product was transported to the plant of the Permanente Metals Corporation, Permanente, where it was fused with imported phosphate rock. The resultant calcium magnesium phosphate (Thermophos) was granulated and sold as a fertilizer for soils deficient in phosphorus and magnesium.

Stone (Dimension)

During the last decade of the nineteenth century and the first decade of the twentieth century the value of building stone was a substantial portion of the annual value of mineral production in California. As labor costs increased both during and following World War I, the use of stone in new buildings was gradually replaced by less expensive concrete construction.

Sandstone was first quarried at the Graystone quarries in Santa Clara County in 1866. These quarries are along the southwest flank of the Santa Teresa Hills, about 9 miles south of San Jose on the road to Almaden. The Cretaceous sandstone occurs as hard, buff-colored, massive beds separated by relatively thin beds of clay shale.

Over half a million dollars worth of this stone was produced between 1900 and 1905 and was used chiefly in the construction of buildings on

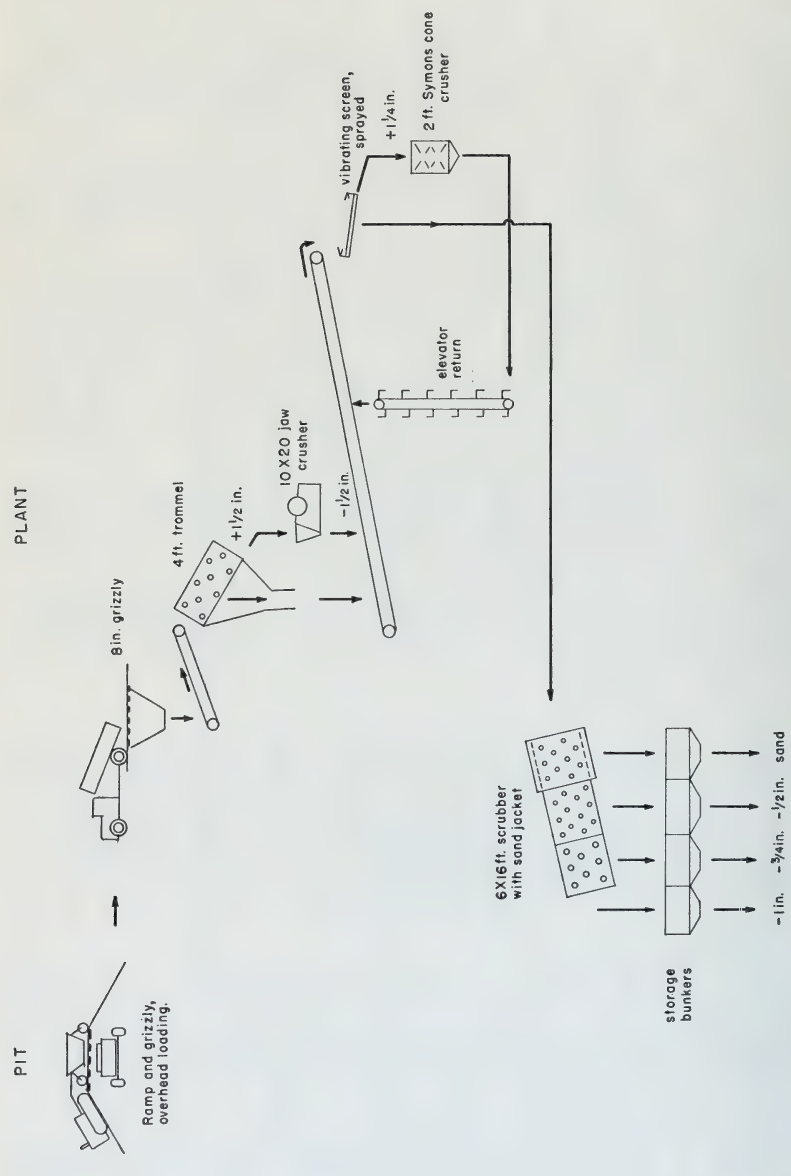


FIGURE 11. Flowsheet of sand and gravel operation.

the campus of Stanford University at Palo Alto. No production has been reported since 1905.

Tertiary sedimentary beds trending northwestward crop out in the hills along the west side of Los Gatos Creek, south of Los Gatos. Included in this locality are buff-colored beds of Vaqueros sandstone of Miocene age. The sandstone is friable but becomes indurated on exposure to the atmosphere. This stone has been used intermittently for many years by property owners in the construction of walls, wine cellars, and local buildings.

Mineral Fuels (Petroleum)

Some of the earliest oil prospecting in California began in Santa Clara County, principally around oil and asphalt seeps at Sargent, and Moody Gulch. Drilling in the Sargent area dates back to 1886. Production, which never amounted to more than a few thousand barrels annually, diminished gradually until the field was abandoned in 1948. The Moody Gulch oil field was discovered in 1878 (Hanks, 1884, p. 151) and has been productive to date. Drilling has been done northeast of Los Gatos; although it began quite early, no commercial production has resulted.

The wide expanse of non-petroliferous Jurassic (?) basement rocks (Franciscan-Knoxville group) which occupies so much of Santa Clara County, limits the areas favorable for oil prospecting. Most of the marine Tertiary sedimentary rocks are so highly faulted and contorted that the structure is complex. The San Andreas, Sargent, Hayward, and Calaveras fault systems, each of major importance in the geologic structure of the central Coast Ranges of Santa Clara County, have also contributed to the disruption of favorable sites for oil accumulation making the task of prospecting for petroleum difficult.

Sargent Oil Field. The Sargent oil field is approximately 7 miles south of Gilroy on Highway 101. As early as 1861, Brewer (1930, p. 126) relates that he visited the ranch of Mr. Sargent and saw "tar springs and oil works, where oil is made from asphaltum." Hanks (1884, p. 289) reported that about 1864 a refinery was built on the Sargent Ranch and asphaltum was taken from rather large seeps along La Brea Creek. These oil and asphalt seeps are very prominent in the region, especially along La Brea Creek where a single seep may cover as large an area as an acre. In nearly every case the seeps are found at the contact between the Monterey and the overlying Purisima formations or along faults in them.

Although drilling dates back to 1886, the minor importance of the area up to 1904 can be judged by the fact that only 20,000 barrels of oil had been recovered. The peak of production was attained in 1909 during which the records show a production of 63,780 barrels of oil. In 1943 eight wells were producing about 625 barrels per month. The first 6 months of 1946 showed a production of 2,530 barrels while during the second half of the year the field was closed in. The field was abandoned in 1948. It is estimated that the field has produced a total of 783,759 barrels of oil to January 1, 1948. The gravity of the oil ranges from 9 to 11 degrees Baumé.

Seven comparatively deep wells have been drilled, most of them east of the producing field. The deepest was drilled to 6,921 feet in 1936 by

Table 8. Wells drilled within the Sargent oil field.

Year drilled	Name of well	Location	Depth (feet)	Depth to oil sand (feet)	Initial production (bbls.)	Average production (bbls.)	Gravity (Baume degrees)	Comments
1906	Watsonville Oil Co. # 1		1,620	704 and 1,603	40	3	17-20	Entered Monterey at 591 ft.
1908	Watsonville Oil Co. # 2		1,218	637-690, 1,184-1,204	250	4		Entered Monterey at 70 ft.
1904	Watsonville Oil Co. # 3		935	?	150-300	15	18-20	Entered Monterey at 175 ft.
?	Watsonville Oil Co. # 4 (Old)	All in Sec. 36, T. 11 S., R. 3 E.	1,904	1,142		0		Entered Monterey at 160 ft.
1913	Watsonville Oil Co. # 4 (New)		902	711-812	Little	4	22	Entered Monterey at 50-70 ft.
?	Watsonville Oil Co. # 5		1,535	947-982, 1,000-1,150		14		
1916	Watsonville Oil Co. # 6		3,050	945	6 to 15	7		
1916	Watsonville Oil Co. # 7	Sec. 31, T. 11 S., R. 4 E.	1,975	350-365	0	0		Conglomerate at 1,900 ft.
?	Watsonville Oil Co. # 8	Sec. 31, T. 11 S., R. 4 E.	1,675	1,515-1,670	0	0		
1916	Watsonville Oil Co. # 9	Sec. 36, T. 11 S., R. 3 E.	1,335		0	0		
1917	Watsonville Oil Co. #10	Sec. 36, T. 11 S., R. 3 E.	1,320	80-110, 450-558	Asphaltum	0		Entered Monterey at 285 ft.
1919	Watsonville Oil Co. #11	Sec. 36, T. 11 S., R. 3 E.	2,020	1,410, 1,445, 1,655, 1,685	5	0	12	Entered Monterey at 95 ft.
1917	Watsonville Oil Co. #12	Sec. 6, T. 12 S., R. 4 E.	1,325			0		Bottomed in soft gray sand.
1918	Watsonville Oil Co. #13	Sec. 36, T. 11 S., R. 3 E.	2,050	1,552-1,560	11-20	9		
1919	Watsonville Oil Co. #14	Sec. 36, T. 11 S., R. 3 E.	1,482	958-1,450	0	5		Entered Monterey between 70 and 120 ft.
1919	Watsonville Oil Co. #15	Sec. 36, T. 11 S., R. 3 E.	740	657-700	18	15-16		Entered Monterey at 90 ft.
1920	Watsonville Oil Co. #16	Sec. 5, T. 11 S., R. 3 E.	?	?				
?	Martin-Zmudowski	Sec. 36, T. 11 S., R. 3 E.	3,552	1,700 or 1,800			36	Entered Franciscan at 3,960 ft.
1906	Martin-De Sabla	Sec. 5, T. 12 S., R. 4 E.	3,680	1,700-1,800			Heavy	
1905 ca.	Chittenden #1 to 7 (#6 in Sec. 2)	Sec. 11, T. 12 S., R. 3 E.	Shallow	Near surface, breas			Heavy	Flow began long after abandoned.
1923	Santa Clara Oil Co. #1	Sec. 1, T. 12 S., R. 3 E.	3,583	3,305				Bottomed in blue shale.
1927	Continental Oil Co. Sar. #1	Sec. 31, T. 11 S., R. 4 E.	3,053					
1928	Continental Oil Co. Sar. #2	Sec. 31, T. 11 S., R. 4 E.	1,681					
1928	Continental Oil Co. Sar. #3	Sec. 1, T. 12 S., R. 3 E.	2,580					All in Pliocene.
1921	Breacita #1	Sec. 5, T. 12 S., R. 4 E.	?					
1925	Petroleum Midway Oil Co. #1 (now Texas Company)	Sec. 10, T. 12 S., R. 4 E.	5,200					
1922	Shell Oil Co. "Lomerias" 1	Sec. 4, T. 12 S., R. 4 E.	4,430					

FIGURE 12. Brea and oil seeps near mouth of La Brea Creek, Sargent oil field.

the Tidewater Associated Oil Company. All seven attempts were dry holes. Table 8 lists wells drilled in the Sargent field.

The formations in the Sargent oil field area include the Franciscan, Monterey, and Purisima. The Upper Jurassic (?) Franciscan rocks crop out north of the Sargent fault and include dark sandstone and shale with masses of serpentine along the fault. Middle and upper Miocene Monterey strata lie in a belt bounded by the Sargent fault and the San Andreas rift. The Monterey section is represented by arkosic sandstone and diatomaceous shale, and is unconformably overlain south of the Sargent oil field by the Pliocene sand and gravel of the Purisima formation.

The most recently published geologic study of the Sargent oil field area shows two northwest trending faults—the Sargent fault and a branch called the Brea fault (Allen 1946). The Sargent fault forms the contact between the Franciscan and Monterey rocks northwest of the oil field. Toward the southeast the Sargent fault passes through the Purisima formation. North of La Brea Creek the Purisima formation is crumpled into closely spaced folds which strike approximately east. South of La Brea Creek a small north-trending anticline lies just south of the Sargent oil field, and may be faulted. This anticlinal structure may be responsible for the entrapment of oil in this field.

Moody Gulch Oil Field. Moody Gulch is a westerly branch of Los Gatos Creek, located about 6 miles south of the town of Los Gatos. The Santa Cruz-Los Gatos state highway now traverses the oil field and many of the former well sites have been obliterated or buried beneath 100 to 200 feet of highway fill.

Most of the oil was encountered in a small area of about 10 acres. The oil field was discovered in 1878 (Hanks, 1884) and most of the drilling in succeeding years occurred before 1912. The wells averaged

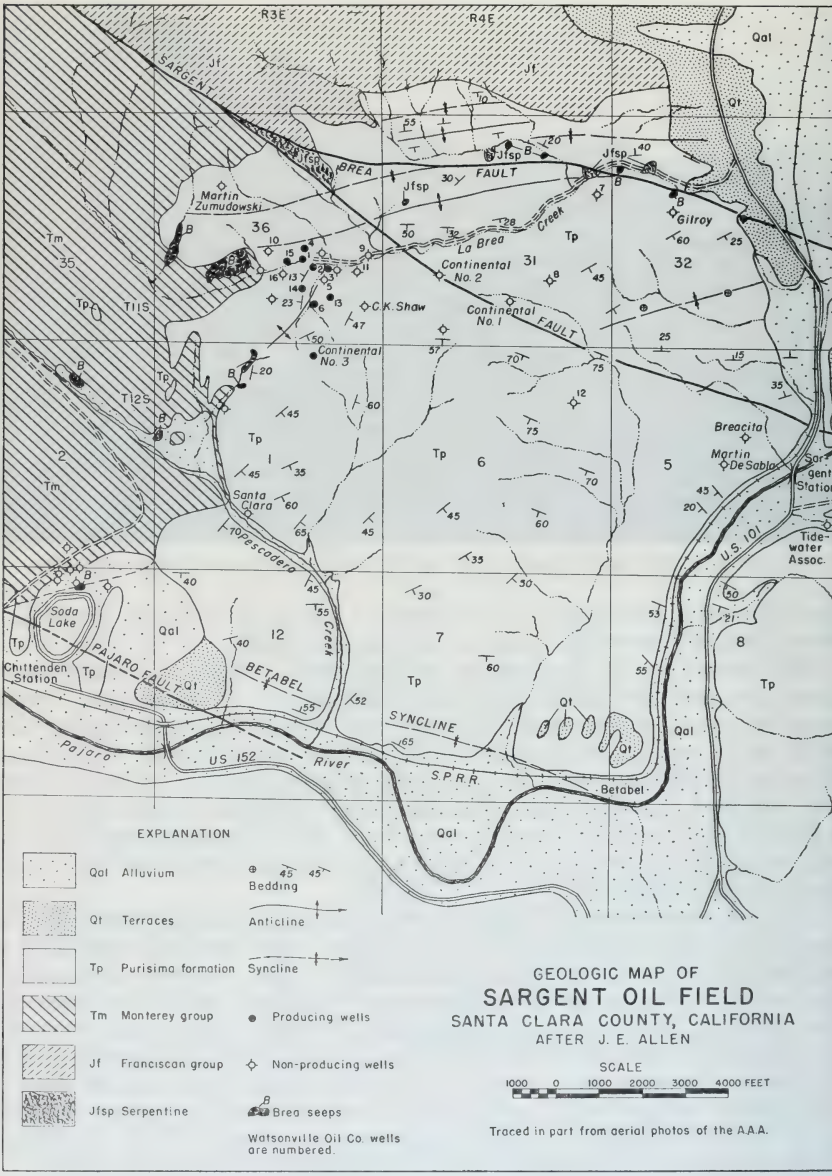


FIGURE 13. Geologic map of Sargent oil field.

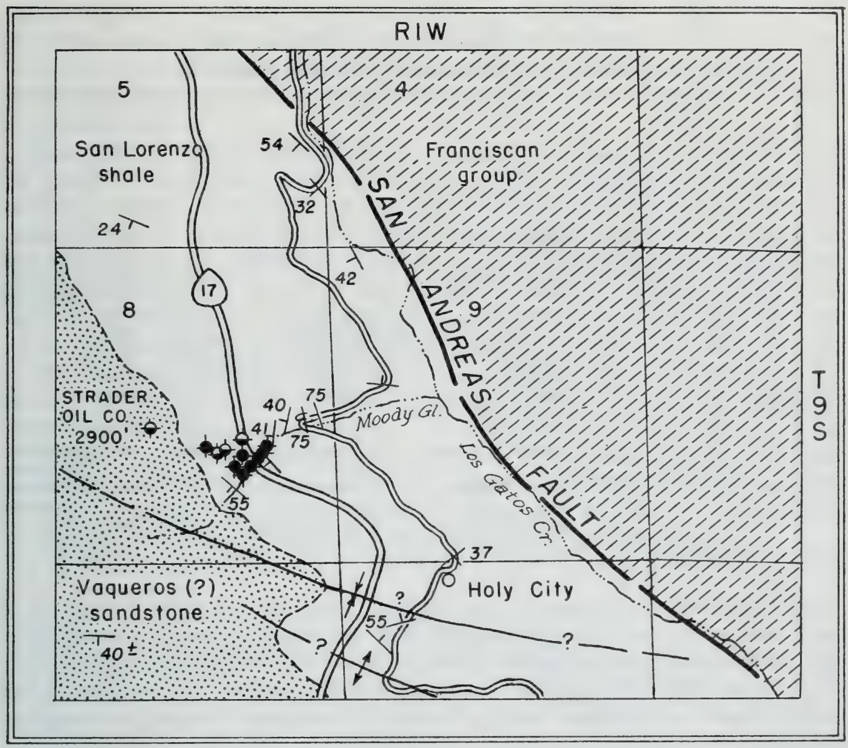
1,200 feet in depth and produced from 10 to 40 barrels per day. Old reports show that the maximum number of wells producing at any one time varied from 14 to 16. Only one well was pumping oil when the field was visited in the summer of 1952. This well, operated by the Gulch Petroleum Company of Los Gatos, was drilled in 1939 to a total depth of 987 feet. It is currently producing 1 to 2 barrels of oil per day.

The production of the Moody Gulch area from January 1 to June 30, 1952, amounted to 228 barrels. The cumulative production of the field to June 30, 1952, was in excess of 63,799 barrels.

An important feature of this oil field is the high gravity of the oil produced. The crude ranges from 40 to 45 degrees Baumé and is a paraffin-type base with only a trace of sulphur.

In the late fall of 1951, the Los Nietos Company drilled a relatively deep test well in sec. 9, T. 9 S., R. 1 W. This test, "Holy City-Well 1," was drilled to 4,659 feet and then redrilled from 1,754 feet to 3,185 feet. It was abandoned in December, 1951.

The geologic formations of the Moody Gulch field consist of Upper Jurassic (?) Franciscan rocks, Oligocene San Lorenzo shale, and Miocene Vasqueros (?) sandstone. The producing area occurs within the San Lorenzo shale. These rocks are peculiarly associated with intrusive andesite, basalt, and altered serpentinized rocks in this district. Because of the small horizontal extent of these intrusive bodies they are



MOODY GULCH OIL FIELD
SANTA CLARA COUNTY, CALIFORNIA
AFTER MAX L. KRUEGER
SCALE
0 1000 2000 4000 6000 FT.

FIGURE 14.

not shown on the accompanying geologic sketch map, figure 14. Surface seeps of light oil have been reported in this formation.

Overlying the San Lorenzo shale is an interval of massive sandstone. This unit probably occupies the same stratigraphic position as the Vaqueros formation but further work may prove it to be upper Oligocene in age.

It is not surprising that the area of the Moody Gulch field, lying as it does about a mile from the San Andreas fault zone, has been highly contorted and squeezed. If the complex detail of the structure is disregarded, the area may be interpreted as a steeply inclined homocline dipping to the southwest. Figure 14 shows the general structure of the region and the formations that crop out.

The first geologists who studied the area did not regard the San Lorenzo as the oil-bearing formation. They believed that the oil had migrated along a fault from a source in the Monterey shales. A more detailed study of the San Lorenzo formation has revealed seepages of light oil within the strata and it is now generally considered that the oil found at Moody Gulch is indigenous to the San Lorenzo shale.

Table 9. Exploratory wells drilled for oil.
(Plotted in center of section on map, plate 2)

Map no.	Location				Company	Well	Year drilled	Depth (feet)	Geology
	Twp.	Rge.	Sec.	B. M.					
60	8S	1W	9	MD	Crossen, Carl	No. 1	1929	615	Bottomed in Miocene?
61	8S	1W	10	MD	Traders Oil Corp.	T-1	1918	2006	Bottomed in Miocene
62	8S	1E	7	MD	Tinnaly, Alfred	No. 1	1927	2356	
63	9S	1W	5	MD	F. C. Farby & L. C. Bowles	Idylwild 1	1951	255	
64	9S	1W	8	MD	Norris, A. R.	Logan 1	Pre-1938	1100	
65	9S	1W	8	MD	Norris, A. R.	Logan 2	Pre-1938	1500	
66	9S	1W	8	MD	Strader Oil Co.	Strader 2	1930	2300	
67	9S	1W	8	MD	Madrone Oil Co.	No. 1			
68	9S	1W	9	MD	Los Nietos Co.	Holy City 1	1951	4659	
69	9S	1E	8	MD	Trigonia Oil & Gas Co.	Trigonia 5	Pre-1925	612	Bottomed in Monterey
70	11S	4E	1	MD	Traders Oil Corp.	Rasmussen 2	1918	2675	Bottomed in Miocene
	12S	3E	1	MD	Santa Clara Oil	No. 1	Pre-1932	3583	No oil

Oil Prospects Northeast of Los Gatos. Most of the area northeast of Los Gatos is covered by Quaternary soil, gravel, and sand. Marine Miocene rocks, which presumably underlie much of the Santa Clara Valley, crop out several miles east of Los Gatos. Wells drilled in the Santa Clara Valley have penetrated rocks of the Monterey formation bearing some oil.

Oil reports show that drilling for oil was carried out near the San Jose reservoir 2 miles northeast of Los Gatos after oil-shows were noticed in an 85-foot water well on a neighboring ranch. Another early well in the locality, on the property of Mrs. H. H. Main, was reported to have reached a depth of 1,600 feet, and gas could be observed bubbling through the oil that filled the casing. These and other early wells in the area were referred to by Vander Leck (1921, p. 64).

In late 1950, Messrs. F. C. Farby and L. C. Bowles drilled a well in the Los Gatos area in sec. 5, T. 9 S., R. 1 W. The well was abandoned in January 1951, after reaching a depth of 255 feet.

MINERAL PROCESSING INDUSTRY

Ferrosilicon

Kaiser Aluminum and Chemical Corporation (Permanente Metals Corporation), Ferrosilicon Plant. Location: Permanente. Ferrosilicon for use in the production of metallic magnesium was made in this plant from 1942 to 1944, during World War II. Since the ferrosilicon process for making the metal costs more than the electrolytic process, the decreased demand for magnesium following the war necessitated closing the plant. It was reopened for a short period during 1949. The plant was rehabilitated in 1951 following the outbreak of the Korean war.

Quartz, scrap iron, and coke are combined in an electric furnace to make ferrosilicon. The quartz is mined from the high silica (98 percent SiO_2) vein deposit at White Rock, Mariposa County. This quartz is supplemented by quartz gravel (plus $\frac{1}{2}$-inch minus 3-inch) obtained from the Bear River, Placer County. Alabama coke, local oil refinery coke, and low-volatile semi-anthracite Oklahoma coal are blended and act as the reducing agent. Scrap is provided in the form of shredded iron turnings.

The raw materials are delivered to receiving bins, dropped to scales for weighing and proportioning of the feed, conveyed to furnace hoppers and fed to three 7000 to 8000 KVA electric furnaces. In the furnace the silica is reduced to silicon, which combines with the iron to form ferrosilicon. The molten alloy is periodically tapped into a bed of ferrosilicon fines where it solidifies. The slag, a calcium-aluminum-silicate, is caught in a sand trough.

Carbon dioxide and other gaseous products of the reaction are conducted to a bag-house where silica is recovered as a by-product. The silica by-product is 2 to 3 microns in size and is used as a binder in refractory brick.

The ferrosilicon produced here contains 75 percent silicon. Although the entire output is consumed in the manufacture of magnesium metal, it could probably be utilized also in the manufacture of high silicon spring steel or high silicon steel used in electrical equipment.

The plant operates on three shifts per day, 7 days a week. About 30 men are employed.

Fiberglas *

Owens-Corning Fiberglas Corporation, Pacific Coast Division. The offices and factory of the Pacific Coast Division of Owens-Corning Fiberglas Corporation are on Kifer Road, Santa Clara. L. R. Kessler is Vice President and General Manager, J. A. Tomlinson is Technical Control Manager, and W. C. McMurray is Purchasing Agent. The Santa Clara plant manufactures a wide variety of Fiberglas thermal and acoustical insulation products.

The first stage in the manufacture of Fiberglas is the production of a special glass in furnaces of the type that is commonly used by the

* This section has been prepared by W. E. Ver Planck, Asst. Mining Geologist, California Division of Mines.

glass industry. Raw materials, including glass sand, limestone, dolomite, soda ash, dehydrated rasorite (sodium borate), and smaller amounts of additional substances are received dry and in granular form. The principal raw materials arrive in bulk by railroad car or truck and are discharged into a hopper below ground level. From there they are raised to the top of a silo that is divided into compartments for the various raw materials. By means of switches near the unloading point, one for each storage compartment, the unloader can direct the material to any compartment he desires.

The preparation of batches of mixed raw materials is controlled from the furnace floor by the furnace operator. The desired quantity of each material is weighed into a revolving mixer housed in the base of the storage silo. The mixed batch is discharged into a batch can of about one-ton capacity. The can is then raised to the furnace floor and moved where needed by means of a system of overhead monorail tracks.

Glass for most of the Fiberglas products is made in a typical regenerative-type glass furnace. The hearth measures 30 feet by 19 feet by 36 inches. Natural gas burners are located along the walls. Air, preheated by means of a chamber filled with hot fire brick checker work, enters the furnace through ports along one wall. Exhaust gases exit through ports on the opposite wall and pass through a second checker chamber on their way to the stack. At intervals of 15 minutes to half an hour the burners are automatically turned off, those on the opposite side are lighted, and the flow of gases is reversed. In this way, the two checker chambers alternately cool the exhaust gases and preheat the incoming air. Provision is made for firing the furnace with oil when natural gas is not available.

Batch cans containing the raw materials mixed in the desired proportions are emptied into the rear of the furnace. Exposed to the direct heat of the gas flames and heat reflected from the furnace roof, the raw materials fuse and combine with the pool of melted glass that fills the hearth. Finished glass continually flows from the front of the furnace into the fore-hearth in which are set V-shaped platinum bushings that contain a number of small holes. The bushings are enclosed in a refractory except for their tips and are heated by electricity. Threads of glass emerging from the holes are caught up and extended by a blast of steam. Their diameter, which is controlled by the temperature of the glass, the temperature of the bushings, and the velocity of the steam is 50- to 70-100,000ths of an inch, about half that of the holes in the bushings.

The tiny glass fibers are collected in a chamber, pressed down between rolls, and emerge in the form of two continuous batts supported on a moving belt. For some Fiberglas products the batts are cut into pieces of the desired size. To make other products the moving batt is bonded by spraying it with thermosetting resin and then passing it through gas-heated tunnel driers. Products such as pipe covering are shaped before the resin is set.

Bonded mat, for wrapping pipe that is to be buried, is made from glass prepared in a smaller furnace of the direct melt type.

Another product, Fiberglas Aerocor, is composed of fibers as small as 3-100,000ths of an inch in diameter and weighs as little as one-half pound per cubic foot, depending on the product desired. In making Aerocor, an alkali-free glass is prepared in four small direct melt fur-

naces. Raw materials, all 325 mesh in size, include silica, whiting, boric acid, and a high alumina clay. In forming the Aerocor fibers, glass flows through bushings in a manner similar to that described above. The glass threads are then caught up and extended by the hot gases and flame from high velocity, high temperature burners, collected, and pressed into batts.

A number of different Fiberglas Aerocor products are manufactured. Aircraft insulation, composed of fibers 3- to 5-100,000ths of an inch in diameter, weighs one-half pound per cubic foot, while the general purpose type Aerocor, with a fiber diameter of 10- to 15-100,000ths of an inch is made with densities from one-half pound to two pounds per cubic foot in the Aerocor curing oven. Recently presses have been installed for curing Aerocor in the range of two pounds up to 60 pounds per cubic foot for dynamic and other specialized applications. In addition, the company is supplying substantial quantities of cushioning rings made of six-pound Aerocor which become an intricate part of the Mighty Mouse guided missiles used in the Korea Air Theatre.

Oyster Shells

Bay Shell Co. Location: Plant at Alviso. Ownership: Bay Shell Co., 1583 E. 14th Street, San Leandro.

Oyster shells deposited on the floor of San Francisco Bay have been recovered annually since 1924 by this company. In 1952 production was coming from a point about $2\frac{1}{2}$ miles north of the San Mateo drawbridge. The shells are small, averaging about 1 inch in diameter. They are mixed with clay and occur in mounds about 30 feet thick.

The shells are recovered from the bay floor by a 5-inch suction pump mounted on a self-propelled barge. The pumping depth is about 10 feet below the surface of the water and the fluid contains about 30 percent solids. The remainder of the fluid is salt water and suspended clay.

The pump discharges the shells to a short trommel where they are scrubbed by clean sea water provided by a second suction pump. The cleaned shells pass to a narrow inclined trough which runs the length of the barge and terminates in the cargo hold where the shells are stored. The capacity of the barge is about 110 tons. This amount can be loaded in 4 hours. The cargo is put ashore on the stock pile by a dragline equipped with a clamshell bucket. The same equipment is also used to deliver shells to the plant receiving bins.

In the plant the shells are automatically fed to a 7- by 31-foot Peoples dryer where about 30 percent of the moisture is removed. The dried shells are elevated to screens for grading. The screen oversize is reduced by rolls to minus $\frac{3}{8}$-inch size and is stored in one of two 400-ton silos.

The final product, 96 percent calcium carbonate, is bagged for shipment in 100-pound units and sold as poultry feed. Some shells are ground in an attrition mill to minus 100-mesh size. This product is used as a filler in feeds.

The plant operates on a 5-day week, and employs 11 men.

Perlite

Expanded perlite was produced commercially during 1947 at the Campbell plant of the National Perlite Company. The crude perlite was produced at a quarry in Napa County.

The crude was ground in a Williams hammer mill and carried on a current of air through a $1\frac{1}{2}$- by 15-foot oil-fired converter. The converter or furnace was inclined a few degrees from horizontal and a temperature of about 2000° F. was attained. Air was supplied by two Schramm diesel compressors, each rated at 420 cubic feet per minute.

On emerging from the furnace, the expanded perlite was cooled, sized over baffle plates, dropped to storage bins, and bagged in 3-cubic-foot containers. The expanded perlite ranged from 3 to 10 pounds per cubic foot in weight.

UNITED STATES NAVAL BOMBING RANGE B-4

The U. S. Naval Bombing Range B-4 embraces about 2400 acres in Stanislaus and Santa Clara Counties, in the Red Mountain district. Only a small part of the range is in Santa Clara County, but the Jones group of manganese claims and the Mexican manganese prospects are located within its confines.

This bombing range was established by authority of the Secretary of the Navy. The leasehold interests in the lands were acquired by procedure instituted pursuant to the Acts of Congress approved August 1, 1888 (40 U.S.C. Section 57) and October 18, 1951 (Public Law 179, 82nd Congress). The action was filed in the District Court of the United States, Northern District of California, Southern Division, on November 28, 1951 under Civil No. 31053.

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TABULATED LIST OF SANTA CLARA COUNTY MINERAL DEPOSITS

The following table lists Santa Clara County mineral deposits in alphabetical order by commodity. The number in the first column refers to the location on the county map, plate 2, in pocket.

The references given in the *Remarks* column refer to the bibliography accompanying this report. Only the last name of the author is given. The first number following the author's name is the abbreviated date of publication as given in the bibliography; the second number, that following the colon, is the page reference.

CHROMITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bay Cities Water Co.	Bay Cities Water Co. San Francisco (?)	S½24	8S	2E	MD proj.	Three miles northeast of Coyote. Small float. Ore in northeast fractures. Grade, 30% Cr_2O_3. Shipped 5 tons in 1918. (Young 18:114; Walter and Griggs 53:87.)
	Black Bird	Henry D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	1,3?	6S	4E	MD	On Arroyo Mocho Creek. High-grade bunches of ore which cropped out were mined in 1917. Extensive areas of disseminated ore. (Young 18:105; Walker and Griggs 53:87.)
	Bonetti	H. Bonetti, San Jose	26,35	9S	2E	MD proj.	Four miles west of Morgan Hill. Five tons of rich float shipped from small serpentine body in 1918. (Young 18:117; Walker and Griggs 53:87.)
	Ferraro	Henry D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	12	6S	4E	MD	Head of Arroyo Mocho Creek. A small outcropping pod of chromite in serpentine yielded 4 tons of ore in 1918. (Young 18:106; Walker and Griggs 53:87.)
	Gassibert	P.J. Gassibert, Coyote	--	--	--	MD	Northeast of Coyote. Extensive, fractured serpentine body extending northwestward in this area. Float from over a distance of 1000 feet. No shipments. (Young 18:116.)
	Greenwalls (Greenwalt)	Chas. Elder (?), New Almaden		9S	1W	MD	Small bunches of chrome in fractured serpentine. About 15 tons shipped in 1917. Total production 150 tons (?). (Young 18:109; Walker and Griggs 53:72.)
	Hahn Ranch	F.H. Tucker, H.E. Jones		8S	1E	MD	Worked prior to 1888. Chromite in serpentine. Shipped 100-200 tons via Guadalupe Narrow Gauge RR. (Irelan 88:549; Walker and Griggs 53:72.)
	Jens	John Jens, Belmont	--	--	--	MD	Shipped 1 ton, 1917. (Logan 18:222; Walker and Griggs 53:87.)
	Kilday Ranch	M.J. Kilday (?), Los Gatos	32 5	8S 9S	1E 1E	MD proj.	Eight miles southeast of Los Gatos. Small lenses of chromite in small bodies of serpentine. Shipped about 80 tons

CHROMITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Kilday Ranch (contd)						in 1916. Total production 175 tons (?) (Bradley and others 18:180; Huguenin and Castello 20:183; Young 18:108; Franke 30:5; Walker and Griggs 53:72.)
	Laurel Lake Ranch	J.A. Ferbrache, Gilroy (shipper)	20	10S	3E	MD proj.	Seven miles northwest of Gilroy. In serpentine along ridge south of Uvas Creek. Some shipments, 1919 (?). Total production 196 tons (?). (Bradley and others 18:180; Huguenin and Castello 20:183; Franke 30:5; Walker and Griggs 53:73).
1A	O'Connell	O'Connell Bros., 6th and St. James Sts. San Jose	31	8S	3E	MD proj.	Chromite as small lenses, and as disseminated grains in extensive body of serpentine; milling ore. (Herein).
	Ramelli	Mary E. Ramelli, Coyote	E½23	8S	2E	MD proj.	Northeast of Coyote. Northwest fractures in serpentine body; 21 tons of 35% ore shipped in 1918. (Young 18:110; Walker and Griggs 53:87.)
1	Smith	F.H. and Maude D. Smith 521 S. San Tomas Rd., Campbell	35,36	7S	1E	MD proj.	Chromite discovered in Edenvale Hills in 1952. Small lens of high-grade chromite. Custom mill in operation in 1953. (Herein).
	Western Magnesite Co.	W. Balkan (shipper)	4	6S	5E	MD	Red Mountain district. Small low-grade deposits. Chromite occurs as granular stringers and disseminated grains in serpentine. Produced 20 tons in 1918. (Walker and Griggs 53:87.)
	Winship	Henry D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	11 SW7	6S 6S	4E 5E	MD MD	Several carloads of high-grade chromite shipped in 1917; 25 tons of 50% Cr_2O_3 concentrate produced in 1919. Total production 290 tons (?). (Bradley and others 18:180; Huguenin and Castello 20:183; Franke 30:5; Walker and Griggs 53:73).
	Yates Lease	M. Rigetti (?), (shipper) San Francisco	S½13	8S	2E	MD proj.	Northeast of Coyote. Northwest fractures in extensive serpentine body carry small pods of chromite. Production, 48

CHROMITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Yates Lease (contd)						tons, 1916-1918. (Young 18:112; Walker and Griggs 53:87.)

CLAY

Map No.	Claim, Mine, or Group	Owner Name, Address	Location Sec.	Location T.	Location R.	Location B & M	Remarks
	Dreischmeyer's Brickyard	San Jose	--	--	--	--	Produced 1,250,000 bricks from Coyote Creek clay in summer of 1895. (Crawford 96:618.)
2	Garden City Pottery Co.	Leased to Garden City Pottery Co., 560 N. 6th St., San Jose	SW$\frac{1}{4}$29	6S	1E	MD proj.	Flower pots made from Coyote Creek clay. (Aubury 06:229; Dietrich 28:219; Franke 30:5; herein.)
	Gilroy Brick and Tile Co.	Chas. Bolfing	1 mi. north of Gilroy				Pre-1928. Small brick plant used local clay shale. Unprofitable. (Dietrich 28:220.)
3	Gladding Bros. Mfg. Co. (Kartschoke Clay Products Co., Peterson Kartschoke Brick Co., Petersons Brickyard).	Gladding Bros. Mfg. Co. 3rd and Keyes Sts., San Jose	NW$\frac{1}{4}$	7S	1E	MD	Manufacture vitrefied clay pipe and allied products. (Crawford 96:618; Boalich 20:97; Dietrich 28:220; Franke 30:6; herein.)
	Handcraft Tile Co. (San Jose Tile Co.)	Handcraft Tile Co., c/o Lloyd Janic, Rt. 6, Box 291, San Jose	Present pit in Alameda County				Hand-made floor and wall tile. (Dietrich 28:221; Franke 30:5; herein.)
	Kartschoke Clay Products Co.	-- --	--	--	--	--	See Gladding Bros. Mfg. Co.
	Pacific Coast Pottery and Terra Cotta Co.	-- --	5th and Keyes Sts., San Jose				Adjoined Gladding Bros. plant. Closed in 1920. (Boalich 20:96.)
	Peterson's Brickyard	-- --	--	--	--	--	See Gladding Bros. Mfg. Co.
	Peterson-Kartschoke Brick Co.	-- --	--	--	--	--	See Gladding Bros. Mfg. Co.
4	Permanente	Permanente Cement Co. Permanente, Calif.	SW17	7S	2W	MD	Altered andesite used in the manufacture of cement. (Herein),

CLAY (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
5	Remillard-Dandini Co. (Remillard Brick Co.)	Remillard-Dandini Co., 321 -13th St., Oakland	15, 16	7S	1E	MD proj.	Common red brick made from Coyote Creek clay. One of the oldest plants in the county. (Crawford 96:618; Dietrich 28:221; Franke 30:6; herein.)
6	San Jose Brick and Tile Co., (San Jose Tile Co.)	San Jose Brick and Tile Co., 1440 Broadway, Oakland	SW24	7S	1W	MD	Common red brick made from Los Gatos Creek clay. (Crawford 96:618; Dietrich 28:221; Franke 30:6; herein.)
	San Jose Tile Co.	-- --	--	--	--	--	See Handcraft Tile Co.
	S and L Tile Co. (S and S Tile Co.)	A. L. Solon, ----- Larkin, F.P. Schemmel	San Jose				Decorative tile made from about 1926-42, using some Coyote Creek clay. (Dietrich 28:221; Franke 30:7.)
	S and S Tile Co.	-- --	--	--	--	--	See S and L Tile Co.

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hahn Ranch	-- --		8S	1E	MD	Worked in 1865 (Irelan 88:549; Jenkins 48:323.)
6A	Hooker Creek	Dr. H.C. Adair, Phelan Bldg., San Francisco	10	9S	1W	MD proj.	Azurite, malachite, pyrrhotite, chalcopyrite; some silver and gold. Prospected intermittently since 1900. (Huguenin 20:184; Franke 30:7; Jenkins 48:323; herein.)
	Laguna Seca Ranch	-- --	36	8S	2E	MD	Chrysocolla and malachite. Prospect. (Weber 90:56 Jenkins 48:323.)
	Masson Ranch	Clyde House, P.O. Box 453, Milpitas (1943)	16	10S	5E	MD	(Jenkins 48:323.)
	Revelation	-- --	--	--	--	--	See Hooker Creek.

LIMESTONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Alameda Sugar Co.	-- --	--	--	--	--	See Permanente.
	Bay Shell Company	Bay Shell Co., 1583 E. 14th St., San Leandro					Shells and agricultural lime. (Franke 30:8; Logan 47:311; herein.)
	Beck Dredging Co.	Capt. L.H. Beck, 305 Parrott Drive, San Mateo (1947)	--	--	--	--	Produced shells between 1931 and 1947(?). (Logan 47:311.)
7	Bernal (California Lime Marl Fertilizer Co., Consolidated Rock and Product Co., Los Gatos Construction Co.?)	Susan Joyce (?) Route 4, Box 282, San Jose	19	8S	2E	MD proj.	Limestone overlain by marl. Worked intermittently since 1915. (Huguenin 20:185; Franke 30:9; Logan 47:311; herein.)
	Black Mountain limestone deposits	-- --	--	--	--	--	See Permanente.
	Bond	A.J. Bond, 564-25th St., Oakland, (1930)	14	7S	3W	MD	Calera limestone on west side of Black Mountain. (Logan 47:313; Franke 30:9.)
	California Lime Marl Fertilizer Co.	-- --	--	--	--	--	See Bernal.
	Clark Ranch	-- --	7 mi.	east	of	Madrone	Deposit of hydraulic lime. (Watts 90:619.)
8	Douglas Ranch (Ellis)	F.W. Wieder (?) c/o Stauffer Chemical Co., 636 California St., San Francisco	SW$\frac{1}{4}$ NW$\frac{1}{4}$ 27	8S	1W	MD	Calera limestone with chert. Shipments to sugar refinery and lime kilns 1886-90. (Irelan 88:544; Logan 47:312; herein.)
	El Dorado Sugar Company	-- --	--	--	--	--	See Permanente.
	Ellis	-- --	--	--	--	--	See Douglas Ranch.

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Guadalupe Lime Co.	-- --	--	--	--	--	Quarries and kilns $2\frac{1}{2}$ miles southeast of Guadalupe mine. (Irelan 88:543; Watts 90:619.)
	Guadalupe Portland Cement Co.	-- --	--	--	--	--	See San Jose Cement Co.
9	Lyndon	L.L. and Wauna Fittinghoff, (?), P.O. Box 443, Los Gatos	28	8S	1W	MD	Calera limestone. (Ecker 33:356; Logan 47:312; herein.)
	Ortley Shell Co.	W.B. Ortley	--	--	--	--	Dredged shells and processed for poultry grits from 1930-41. (Franke 30:9; Logan 47:312.)
10	Permanente Cement Co. (Black Mountain limestone deposit, Santa Clara Holding Co., Alameda Sugar Co., El Dorado Sugar Co.)	Permanente Cement Co., Permanente	17,18	7S	2W	MD	Used in manufacture of cement. (Aubury 06:82; Huguenin 20:185; Franke 30:9; Logan 47:313-317; Davis 49:117; herein.)
	San Jose Cement Co. (Guadalupe Portland Cement Co.	-- --	4,5 32	9S 8S	1E 1E	MD MD	Undeveloped. (Franke 30:9; Logan 47:313.)
	Winship	Henry D. Winship and Katherine W. Hayes, 350 Post St., San Francisco	SW$\frac{1}{4}$ 13	7S	3W	MD	On southwest side of Black Mountain; undeveloped. (Logan 47:317.)
	Wright's Ranch	-- --	5 mi. southeast of New Almaden				Marble (?), undeveloped. (Crawford 94:394; Logan 47:317.)

MAGNESITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	American Magnesite Co.	-- --	--	--	--	--	See Western.
	Black Bird Valley	-- --	--	--	--	--	See Hoff Magnesite Co., Inc.
	Bradford Ranch	Herbert S. Bradford	4 mi. southeast of Edenvale				Small veins in serpentine; production 1917. (Bradley 25: 78.)
	Burnett Ranch	-- --	3 mi. northeast of Coyote.				Veins and boulders in serpentine. (Bradley 25:78.)
	Cochrane Ranch (Jackson Ranch)	-- --	$4\frac{1}{2}$ mi. east of Madrone.				Worked in 1897 and 1916. (Aubury 06:331; Bradley 25:79.)
	Fidelity	Leased to Western Magnesite Mining Co.	SW$\frac{1}{4}$12	6S	4E	MD	No production (Bodenlos 50:274.)
	Hoff Magnesite Co., Inc. (Black Bird Valley)	-- --	13	6S	4E	MD	Vertical kiln built on property. (Bradley 25:79.)
	Jackson Ranch	-- --	--	--	--	--	See Cochran Ranch.
	Maltb	-- --	--	--	--	--	See Western.
	O'Connell Bros. (Weber Ranch)	O'Connell Bros. 6th and St. James Sts., San Jose	3 mi. northeast of Madrone.				Some production 1916 to 1919. (Aubury 06:331; Bradley 25: 80.)
	Pacific Magnesite Co.	-- --	--	--	--	--	See Western.
	Security	Leased to Western Magnesite Mining Co.	NE$\frac{1}{4}$13	6S	4E	MD	Surface production World War I. (Bodenlos 50:274.)
	Standard Magnesite Co.	-- --	--	--	--	--	Operated the Security claim in 1918. (Bradley 25:81; Bodenlos 50:274.)
	Weber Ranch	-- --	--	--	--	--	See O'Connell Bros.

MAGNESITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
11	Western (Maltby, Pacific Magnesite Co., Western Magnesite Development Co., American Magnesite Co.)	Western Magnesite Mining Co. c/o Westvaco Chemical Div., Food Machinery and Chemical Corp. Newark	18	6S	5E	MD	Nodular aggregates replacing serpentine, and fissure-filling in irregular fractures, breccia zones and open shears. Production over 870,000 tons. (Watts 93:374; Crawford 96:505; Aubury 06:330; Hess 08:31; Huguenin 30:189; Laizure 24:29; Bradley 25:81; Palmer 27:747; Perry 42:35; Bodenlos 50:223-278; herein.)
	Western Magnesite Development Co.	-- --	--	--	--	--	See Western.
	Winship	Henry D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	1 SW$\frac{1}{4}$7	6S 6S	4E 5E	MD MD	Several carloads shipped 1916. (Bradley 79:87.)

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Acme Lode	James Renfrew, J.W. Bonsack, Ralph Bolt	NW¼30	6S	5E	MD	Siliceous oxides in white chert, rhodochrosite in creek; grade 4 to 25% Mn. (Trask 50:245.)
	Aitken-Wolfe						See Winship.
	Ala Mountain	Herman A. Biel, 765 Polhemus St., University grounds, San Jose	28	5S	4E	MD	Some production prior to World War I. (Aubury 06:336; Bradley and others 18:75; Trask 50:246.)
	Antonio	Matt Keller	32	6S	5E	MD	Thin films of oxide and disseminated carbonate; grade 10% Mn. (Trask 50:246.)
	Avery	Geo. D. Avery, Porterville (1918)	--	--	--	--	Exact location unknown. (Trask 50:246.)
	Billy Goat (Wasp-KHD)	John Pattner, Livermore (1918)	12	6S	4E	MD	Produced 49 tons in 1917. (Trask 50:246.)
	Black Ball Lode	Paul Gerber (?) Livermore	NW¼34	6S	5E	MD	County assessors map.
	Black Bear	D.P. Doak, Rialto Bldg. San Francisco (1918)	34	5S	4E	MD	Interbedded lenses of manganese ore in jasper. (Aubury 06:336; Bradley and others 18:75; Trask 50:246.)
	Black Beauty	--	--	--	--	--	See Turner.
	Blackbird (Blackhawk)	M.E. Fisher	NE¼28	6S	5E	MD	Siliceous manganese oxide; av. grade 25% Mn. (Bradley and others 18:76; Trask 50:246.)
	Black Bird Lode	Hazel J. Williams, P. O. Box 515, Patterson	SW¼28	6S	5E	MD	County assessors map.
12	Black Eagle	Mrs. Antonia Harris	SE¼28	6S	5E	MD	Siliceous manganese oxide; av. grade 25% Mn; 40 tons shipped 1940-42. (Trask 50:247.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Blackhawk	-- --	--	--	--	--	See Blackbird.
13	Black Horse	Mrs. Antonia Harris	NE$\frac{1}{4}$32	6S	5E	MD	Pockets of high-grade oxide ore; av. grade 20% Mn. 40 tons shipped 1939-42. (Trask 50:247.)
	Black Wonder	-- --	--	--	--	--	See Jones group.
	Camp Bessie	-- --	--	--	--	--	See Fable.
	Cedar Tree	Mrs. Antonia Harris and Matt Keller	33	6S	5E	MD	Disseminated oxide in chert and low-grade ore. (Trask 50:248.)
14	Cottonwood	Matt Keller	SW$\frac{1}{4}$28	6S	5E	MD	Siliceous manganese oxide; av. grade 40% Mn; 40 tons sold 1940-42. (Trask 50:248.)
	Davenport	-- --	--	--	--	--	See Winship.
	Davenport and Smith	-- --	--	--	--	--	See Winship.
	Dead Oak	-- --	--	--	--	--	See Keller.
	De Forest	-- --	12	7S	4E	MD	Pocket manganese ore; undeveloped. (Trask 50.249.)
	Doak #2	Otto E. Biel, Livermore	22 or 27	5S	4E	MI	Manganese ore in chert; a few tons produced. (Aubury 06:337; Bradley and others 18:77; Trask 50:249.)
	Fable (Camp Bessie)	Tom Green (1917)	34	5S	4E	MD	Manganese oxides and silica; compact and cellular ore in chert and shale. Some production during World War I. (Aubury 06:337; Bradley and others 18:78; Trask 50:249.)
	Frankel	Frankel Ranch		6S	2E	MD	Stains of manganese oxide (Trask 50:250.)
	Great Expectations	-- --	--	--	--	--	See Newhall.

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
15	Jones group	Operated by Western Manganese Co. in 1940	27	6S	5E	MD	In Naval Bombing Range B-4. Largest group in this area; high-grade massive oxide in beds 3 to 5 ft. thick enclosed in chert; grades into rhodochrosite; some low-grade siliceous oxide; grade ranges from 20 to 40% Mn; 400 tons high-grade oxide shipped in 1941. (Bradley and others 18:78; Trask 50:251.)
16	Keller (Deak Oak)	Operated by Barker Corp in 1942	NW¼32	6S	5E	MD	Massive black oxide; 1684 tons produced 1940-42; sold to General Dry Battery plant at Patterson (since removed). (Trask 50:253.)
	Keller Bros.	Keller Bros. Ranch	13	6S	4E	MD	No production. (Bradley and others 18:78; Trask 50:253.)
	Kelley	Ed Kelley, Mrs. Plattner, Wm. Hampton (1917)	MW¼12	6S	4E	MD	Manganese carbonate in chalcedonic silica; grade 20-35% Mn, 5-15% Fe, 25+% silica. (Trask 50:255.)
	Kelley, A.N.	A.M. Kelley, Morgan Hill (1917) Morgan Hill Ranch	lot 16 map 3	9S	3E	MD	Siliceous ore prospect. (Trask 50:254.)
	Lopez	Rainey Ranch	19?	9S	3E	MD	
	Mammoth	H.H. Ballentine (1917)	13	6S	4E	MD	Siliceous oxide ore. (Bradley and others 18:78; Trask 50:254.)
	May Be	Mrs. Antonia Harris	SE¼28	6S	5E	MD	Low-grade oxides in massive white chert, grades from 10 to 20% Mn. (Trask 50:255.)
	McCoy	C.L. McCoy, San Jose	--	--	--	--	Produced 15 tons of ore, 31.6% Mn, in 1942. (Trask 50:255)
	McPherson	J.L. McPherson	--	--	--	--	Delivered 8 tons ore containing 35.9% Mn in 1942. (Trask 50:255.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mateos Ranch	John D. Mateos, 165 N. 15th St., San Jose	8	6S	2E	MD	Shipped 40 tons in 1917. (Bradley and others 18:79; Trask 50:254.)
	Mexican	-- --	27	6S	5E	MD	In Naval Bombing Range B-4. Siliceous manganese oxide in chert; av. grade 25% Mn. (Trask 50:255.)
	Miller	Caldwell and Albrecht (1918)	--	--	--	--	Reported production 189 tons ore containing 35% Mn. (Trask 50:255.)
	Mineral Products Co.	Hazel J. Williams, P.O. Box 515, Patterson	28	6S	5E	MD	Manganese oxides. (Bradley and others 18:78.)
	Morgan Hill	Morgan Hill Water Works (1917)		9S	3E	MD	Siliceous ore; produced 70 tons. (Trask 50:256.)
	Mt. Hamilton	H. Backman, Berkeley		7S	3E	MD	Prospect; 10% Mn. (Trask 50:256.)
17	Murmac group	A.H. Jones, B.E. Cronkheit, Mary Lou Smith, Lee Neideffer; operated by West Coast Chrome Co. in 1941	SW$\frac{1}{4}$21	6S	5E	MD	Five ore bodies; lenses of bedded ore in white chert; siliceous black oxides; grades from 10 to 45% Mn; total production 224 tons in 1941. (Trask 50:256.)
	Newhall (Great Expectations)	H.D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	36	5S	4E	MD	Manganese oxide and patches of residual silica in chert. Exploration possibilities. (Bradley and others 18:79; Trask 50:250.)
	Newsom	Archie Newsom, Livermore	SE$\frac{1}{4}$26	5S	4E	MD	Siliceous ore; 25 tons of 15% Mn ore in sight. (Trask 50:257.)
	Nigger Head Lode	Hazel J. Williams, P.O. Box 515, Patterson	SW$\frac{1}{4}$28	6S	5E	MD	County assessors map.
	Noble	-- --	--	--	--	--	See Pennsylvania.

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Penitencia Creek	-- --	--	--	--	--	See San Jose.
	Pennsylvania	M.M. O'Day, San Jose (1917)	SW$\frac{1}{4}$12	7S	4E	MD	Siliceous ore; produced 200 tons ore in World War I. (Bradley and others 18:78; Trask 50:258.)
18	Pine Ridge	Roger W. Jessup, 5431 San Fernando Rd., Glendale, 3; leased to Alfred Jackson, Morgan Hill, in 1942	31	8S	4E	MD	Discontinuous outcrops of manganese oxide; produced 426 tons ore averaging 38% Mn in 1941-42; can be hand sorted. (Trask 50:259.)
	Pulse	Jack Pulse, Livermore	SW$\frac{1}{4}$26	5S	4E	MD	Small pockets good grade oxide ore in pink chert. Operated in 1918. (Trask 50:262.)
19	Queen Bee	Calvin McMillan; leased to Barker Corp. in 1942	SW$\frac{1}{4}$29	6S	5E	MD	Stockwork ore in white chert; grade 15 to 30% Mn; produced 45 tons ore in 1942. (Trask 50:262.)
	Rainey Ranch	-- --	--	--	--	--	See Lopez.
	San Jose (Penitencia Creek)	-- --	27	6S	2E	MD	A boulder yielded 329 tons of ore in 1918; grade 43.2 to 63.5% Mn; none remains; various manganese minerals. (Rogers 19:443; Trask 50:263.)
	Summit	-- --	--	--	--	--	See Turner.
	Triple Jump	W.J. Schroeder	SW$\frac{1}{4}$28	6S	5E	MD	Siliceous manganese oxide in white chert; av. grade 25% Mn. (Trask 50:263.)
	Turner	Robert and George C. Turner	NE$\frac{1}{4}$26	5S	4E	MD	Siliceous ore; production 50 tons reported in 1917. (Trask 50:263.)
	Wallace Ranch	Mrs. Grade P. Wallace, San Jose	8	6S	2E	MD	Small outcrop of high-grade manganese ore. (Bradley and others 18:79; Trask 50:264.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Wasp-KHD	-- --	--	--	--	--	See Billy Goat.
20	Winegar	H.D. Winship, Katherine W. Hayes, 350 Post St., San Francisco; leased to Phil Winegar, Vernalis, in 1942	19	5S	4E	MD	Two beds of siliceous oxide separated by barren chert; surface ore 15-20% Mn; ore sorted to yield 35% Mn; production to 1942 was 299 tons. (Trask 50:264.)
	Winship (Davenport, Davenport and Smith)	H.D. Winship, Katherine W. Hayes, 350 Post St., San Francisco	27,35	5S	4E	MD	Siliceous manganese oxide; production 125 tons World War I, 12 tons World War II. (Bradley and others 18:80; Trask 50:248.)

MINERAL SPRINGS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Alma Soda	San Jose Water Works; distributed by C. Wood, 1075 Luther St., San Jose (1930)	--	--	--	--	Magnesia, sulfur, soda. and iron; near Alma. (Franke 30:16.)
	Alum Rock Park	City of San Jose	--	--	--	--	Numerous small springs of varied chemical character. (Franke 30:16.)
	Azure (Mills Seltzer)	-- --	--	--	--	--	Magnesia; marketed pre-1890; near Saratoga. (Franke 30:18.)
	Blodgett Magic	-- --	--	--	--	--	Tastes slightly saline; west of Gilroy. (Franke 30:19.)
	Blodgett Mineral (Magnesia)	-- --	--	--	--	--	Magnesia; west of Gilroy. (Franke 30:19.)
	Calaveras Mountain	J. Daniels; leased by Calaveras Water Co., G.W. Fieger, 354 E. Santa Clara St., San Jose	--	--	--	--	Sodium and calcium carbonate. (Franke 30:20.)
	Coes	-- --	--	--	--	--	Carbonated; east slope of Pine Mountain. (Franke 30:19.)
	Congress (Pacific Congress)	Peninsular Railroad Co. (1930)	--	--	--	--	Carbonated; site of recreation park; near Saratoga. (Franke 30:20.)
	Gilroy Hot	-- --	--	--	--	--	Health resort established in 1865; 13 miles northeast of Gilroy; water was carbonated and bottled at Gilroy. (Franke 30:21.)
	Grant	-- --	--	--	--	--	Sodium and magnesium carbonate; Alum Rock Canyon. (Franke 30:21.)

MINERAL SPRINGS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hillydale Sulfur	-- --	--	--	--	--	Sulfur; $4\frac{1}{2}$ miles south of New Almaden mine. (Franke 30: 21.)
	Madrone	-- --	--	--	--	--	Carbonated; 14 miles east of Madrone; formerly bottled at San Jose. (Franke 30:22.)
	Magnesia	-- --	--	--	--	--	See Blodgett Mineral.
	Mills Seltzer	-- --	--	--	--	--	See Azule.
	Santa Clara Park (Soda Rock)	Santa Clara County	--	--	--	--	Five miles west of Cupertino at Stevens Creek Park. (Trask 30:22.)
	Santa Teresa	P.A. Bernal, Edenvale (1930)	--	--	--	--	Slightly mineralized; east slope of Santa Teresa Hills (Franke 30:22.)
	Soda Rock	-- --	--	--	--	--	See Santa Clara Park.

QUICKSILVER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bernal	Pedro A. Bernal, Edenvale (1930)	--	--	--	--	East slope Santa Teresa Hills. A 200-ft. adit on clay serpentine contact failed to find an ore body. (Franke 30:29; Forstner 03:171.)
	Bowie	Circle B. Mining Co. (1918)	--	--	--	--	Prospect. (Bradley 18:157.)
	Brainard	Mrs. M.D. Brainard et al., San Jose (1918)	--	--	--	--	Old adit cut cinnabar. (Bradley 18:157.)
	California-Nevada Quicksilver Mining Co. (Tilton Ranch, Coyote)	Otto Taubert, 800 Carmel Ave., Berkeley (1930)	--	--	--	--	Prospecting in 1929-30 on Tilton Ranch 18 mi. southeast of San Jose. (Franke 30:29.)
	Chaboya	-- --	--	--	--	--	See Hillsdale, and New Almaden.
	Chapman	-- --	--	--	--	--	See Hillsdale.
21	Comstock	Della French, et al., 508 Powell St., Hollister	19	11S	7E	MD	Mine in serpentine-silica carbonate rock; structural control by northeastward fault, dipping southward. Cinnabar associated with silica occurs above the fault in silica-carbonate rock; some meta-cinnabar. Lower workings flooded in 1941. Estimated production 1870-80 was 300 flasks; estimated reserves 100 flasks. (Bailey and Myers 42:54.)
	Costello	-- --	--	--	--	--	Prospect on west side of Los Capitancillos Creek, 1½ miles southeast of Guadalupe mine. (Forstner 03:172.)
	Coyote	-- --	--	--	--	--	See California-Nevada Quicksilver Mining Co.
	El Senador	-- --	--	--	--	--	See Senator.
22	Enriqueta	Richard H.L. and Eric H.L. Sexton, 444 W. Chestnut Ave., Chestnut	33	8S	1E	MD proj.	Part of the New Almaden property. Yielded 10,571 flasks 1859-65, included in New Almaden production total. (Bradley 18:164.)

QUICKSILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
22	Enriqueta (contd)	Hill, Pennsylvania					
23	Guadalupe	H.S. Young, R.G. Hudson, B.F. Rabinowitz, estate of J.S. Gregory, Matt Wahrhaftig; represented by Matt Wahrhaftig, Bank of America Bldg., 12th and Broadway, Oakland	30	8S	1E	MD proj.	Cinnabar-bearing silica-carbonate zones between serpentine and sandstone. Total production 110,087 flasks. (Irelan 88:542; Forstner 03:173; Bradley 18:152-160; Franke 30:29; Ransome 39:451; Sayers 42:04; 43:111; Huttl 44:86; Davis 49:117; Bedford and Ricker 50; herein.)
24	Hillsdale (Oak Hill, San Juan Bautista, Chapman, Chaboya)	Manuel Lewis, San Jose; or Manuel T. Azevedo, 555 S. 16th St., San Jose	28,33 (?)	7S	1E	MD proj.	Silica-carbonate zone between serpentine and Franciscan sandstone. Discovered 1847. Produced intermittently 1847-74, 1892-1907, 1915, and during World War II; total 163 flasks. (Forstner 03:174; Bradley 18:160; Crittenden 51:62.)
	Miller	-- --	--	--	--	--	See Santa Clara Quicksilver Corp.
25	New Almaden (Chaboya, Santa Clara)	Richard H.L. and Eric H.L. Sexton, 444 W. Chestnut Ave., Chestnut Hill, Pa.	3	9S	1E	MD proj.	Cinnabar ore bodies occurred as replacement of silica-carbonate rock along steep northeast-trending fractures. Total production 1846-1951 was 1,051,041 flasks, including production from Enriqueta, Senator, and New Almaden dumps and placers. (Lyman 48:270; Hart 51:139; Blake 54:438; Whitney 65:68; Goodyear 82:111; Christy 85:547-584; Becker 88:310-330; Forstner 03:168-171; Bradley 18:160-167; Franke 30:29; Schuette 31:411-417; Ransome 39:452-454; Huttl 43:59-61; Sayers 43; Heizer 44:311; Sayers 45; Bailey-Everhart 47:77; Davis 49:116; Bedford and Ricker 50; Bailey 51:263-270; Bailey 52; herein.)
26	New Almaden placers and dumps	Richard H.L. and Eric H.L. Sexton, 444 W. Chestnut Ave., Chestnut Hill, Pa.	2	9S	1E	MD proj.	Furnace calcine dumps; and placers at base of Mine Hill. Chiefly owned by New Almaden mine, leased periodically. Production included in New Almaden total. (Franke 30:31; Bailey and Everhart 47:77.)

QUICKSILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
27	New North Almaden (Santa Clara, Santa Clara Quicksilver Mining Corp., Piercy, Miller.)	Jacob and Grace Miller	5	8S	2E	MD proj.	In Silver Creek Hills. Worked pre-1906. Prospected 1928, small production 1930. Prospected during World War II. (Franke 30:31; Ransome 39:455; Crittenden 51:63.)
	North Almaden	-- --	--	--	--	--	See Silver Creek.
	North Line	-- --	--	--	--	--	See Senator.
	Oak Hill	-- --	--	--	--	--	See Hillsdale.
	Piercy	-- --	--	--	--	--	See Santa Clara Quicksilver Corp.
28	Rianda	A.A. Rianda, Route 1, Box 216, Gilroy	22	10S	4E	MD	Northeast of Gilroy. Small production World War II.
	Santa Clara	-- --	--	--	--	--	See New Almaden, and New North Almaden.
	Santa Clara Quicksilver Corp.	-- --	--	--	--	--	See New North Almaden.
29	Santa Teresa	Enos Fontis, Edenvale (1920)	24	8S	1E	MD	East slope, Santa Teresa Hills. Silicified fracture zone in serpentine carried cinnabar, quartz, calcite, pyrite. Small production about 1903. (Forstner 03:186; Huguenin 20:224.)
30	Senator (El Senador, North Line)	Richard H.L. and Eric H.L. Sexton, 444 W. Chestnut Ave., Chestnut Hill, Pa.	29	8S	1E	MD proj.	Part of the New Almaden property. About 4 miles northeast of Mine Hill; adjoins Guadalupe. Principal production from 1917-25. In 1917 employed 105 men, including 60 underground. Production included in New Almaden total. (Huguenin 20:216-224.)
31	Silver Creek (North Almaden)	Lee Slatore, Route 3, Box 442, San Jose;	33	7S	2E	MD proj.	Cinnabar in small veins in silica carbonate rock; Silver Creek fault zone. Production between 1893-1904 and 1928-

QUICKSILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
31	Silver Creek (North Almaden) (contd)	leased by Sam Cohen in 1942-43)					1943 totalled 367 flasks. (Franke 30:32; Ransome 39:458; Crittenden 51:60.)
	Tilton Ranch	-- --	--	--	--	--	See California-Nevada Quicksilver Mining Corp.
	Wright	Mrs. A. Rodgers, 1801 Leavenworth St., San Francisco (1903)	--	--	--	--	On Llagas Creek, 3 miles south of New Almaden mine. Produced some good ore pre-1903. (Forstner 03:187; Bradley 18:168.)

ROCK (CRUSHED)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Alum Rock	City of San Jose	--	--	--	--	Siliceous shale. (Huguenin 20:225.)
	Anderson	G.H. Anderson, Mountain View (1930)	--	--	--	--	Three miles southwest of Los Altos. (Franke 30:35.)
32	Anderson Lake	O'Connell Bros (?) Route 4, Box 279, Cottle Rd., San Jose	10	9S	3E	MD proj.	Silicified serpentine. Rip-rap and dam rock. (Herein.)
33	Bahr & Ledoyen, Inc.	Leased to Bahr & Ledoyen, 3291 - 3d St., Palo Alto	26	6S	3W	MD proj.	Franciscan rocks, Page Mill Road; road rock. (Herein.)
34	Commercial Materials	c/o Guy F. Atkinson 10 W. Orange Ave., So. San Francisco	22	7S	2W	MD proj.	Santa Clara formation, Stevens Creek; fill rock. (Herein.)
35	County		23	6S	1E	MD proj.	Cemented Oakland conglomerate; road and fill rock. Mouth of Penitencia Creek, Alum Rock Park. (Herein.)
36	County (Saratoga Rock, Quality Sand & Rock, Stanfield & Knowles)	Santa Clara County Quarry, Saratoga	11	8S	2W	MD	Metamorphosed sandstone, road rock; one mile west of Saratoga. (Herein.)
37	Fredrickson-Watson	L.L. Winterbower, Route 2, Box 899, Milpitas; leased to Fredrickson-Watson Construction Co. Milpitas	4	6S	1E	MD proj.	Monterey shale; road rock. (Herein.)
	Hillsdale	-- --	34?	7S	1E	MD	Sandstone, road rock. (Huguenin 20:226.)
	Gay	-- --	--	--	--	--	See Oak Hill (stone).
	Kelley	-- --	--	--	--	--	Serpentine, north of Morgan Hill. (Franke 30.35.)

ROCK (CRUSHED, Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
38	Lone Hill	Lone Hill, Inc., c/o Mirasson Bros., 15630 Harwood Road, Los Gatos	7,18	8S	1E	MD proj.	Rhyolite, road rock. (Herein.)
	Neary	-- --	--	--	--	--	See Sondgrath Bros.
	Oar	Jim Oar, Mayfield (1930)	--	--	--	--	Four miles south of Mayfield. (Franke 30:36.)
39	Piazza	Leo F. Piazza, Route 1, Box 800, San Jose	23	6S	1E	MD proj.	Santa Clara formation near mouth of Penitencia Creek, Alum Rock Park. (Herein.)
40	Piazza	Leo F. Piazza, Route 1, Box 800, San Jose	21 or 22	7S	2W	MD	Santa Clara formation; Stevens Creek. (Herein.)
	Quality Sand & Rock	-- --	--	--	--	--	See County.
41	Rhodes & Robinson (Stanford)	Leland Stanford University, Palo Alto	23	6S	3W	MD proj.	Basalt. Idle, equipment removed. (Herein.)
42	Roggasch Bros.	c/o Arnold Roggasch, 135 Palo Ave., San Jose	6	6S	1E	MD proj.	Cemented Oakland conglomerate, east of San Jose; installing crusher. (Herein.)
	Saratoga	-- --	--	--	--	--	See County.
43	Senator Dump	Leased to Al Routt, 19112 Tilson Ave., Cupertino	29	8S	1E	MD proj.	Furnace calcines; fill rock. (Herein.)
44	Sondgrath Bros. (Neary)	Ethel B. Neary, Route 1, Box 604, Los Altos; leased to Sondgrath Bros., Route 1, Box 146 Mountain View	6	7S	2W	MD proj.	West of Los Altos, fill rock. (Herein.)

ROCK (CRUSHED, Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Stanfield-Knowles	-- --	--	--	--	--	See County.
	Stanford	-- --	--	--	--	--	See Rhodes-Robinson.
	Swickard	J.H. Swickard, Route 4, Box 376, San Jose (1930)	--	--	--	--	Ornamental rock. (Franke 30:39).
	Taafe Construction	Taafe Bros., Los Altos (1930)	--	--	--	--	Three miles west of Los Altos. (Franke 30:39.)
45	Voss	A.F. and V.L. Voss, 10445, S. Stevens Creek Road, Cupertino	28	7S	2W	MD	Santa Clara formation, Stevens Creek. (Herein.)
	Winterbower	-- --	--	--	--	--	See Fredrickson-Watson.

SALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Alviso Salt Co.	Leslie Salt Co., San Francisco		6S	1W	MD	Solar evaporation. Plant constructed between Mayfield and Alviso in 1923(?). No production after 1930. (Franke 30:33; Bartlett 30:22-26.)

SAND AND GRAVEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Associated Gravel Co.	-- --	--	--	--	--	See Pacific Coast Aggregates, Inc.
	Bay Development Co.	-- --	--	--	--	--	See Pacific Coast Aggregates, Inc.
46	Brem Bros.	Samuel Hamburger, Inc. 110 Sutter St., San Francisco; leased to Brem Bros., 211 N. Princeville, Gilroy	1	11S	3E	MD proj.	Franciscan rocks; Carnadero Creek, Gilroy. (Herein.)
	Bright Gravel Co.	W.H. Bright, E.W. Heple, Route 2, Box 631, Berryessa Road, San Jose	--	--	--	--	Coyote Creek, south of San Jose. (Franke 30:35.)
	Carroll	W.A. Dunlap, San Jose (1930)	--	--	--	--	Coyote Creek, south of San Jose. (Franke 30:35.)
47	County	Samuel Hamburger, Inc. (?); leased to Santa Clara County	1	11S	3E	MD proj.	Franciscan rocks; Carnadero Creek, Gilroy. (Herein.)
48	County	-- --	11 or 12	10S	3E	MD	Franciscan rocks, Llagas Creek, San Martin. (Herein.)
	Coyote	E.B. and A.L. Stone Co. (1930)	--	--	--	--	Half a mile south of Coyote station. (Huguenin 20:226.)
	Crummey, Inc., Raymond H.	-- --	--	--	--	--	See Prentiss Paving Co.
	Los Gatos Aggregate Materials	Johnson & Rinehart, 138 E. Main St., Los Gatos	--	--	--	--	

SAND AND GRAVEL (Cont.)

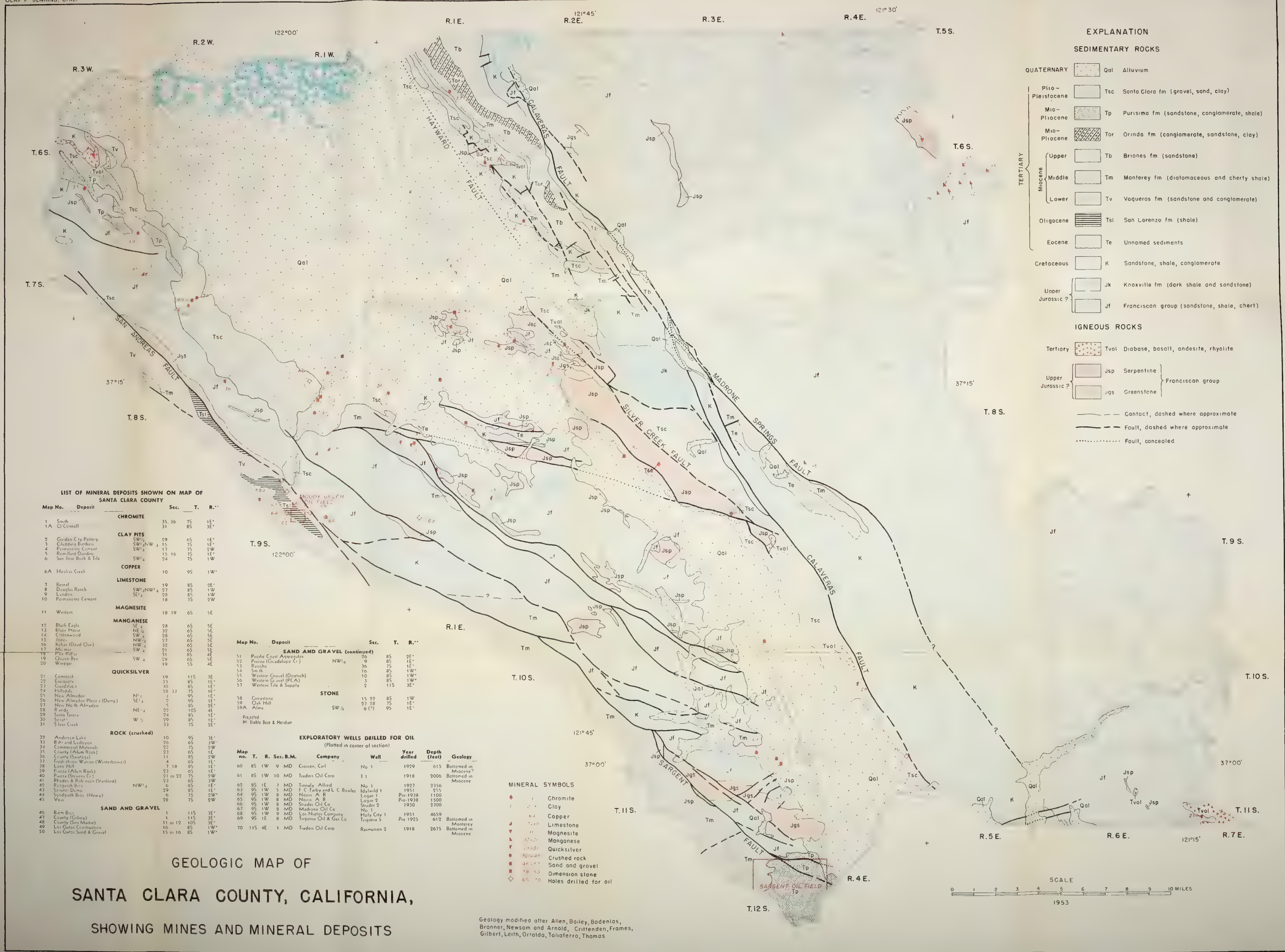
MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
49	Los Gatos Construction Co.	Los Gatos Construction Co., P.O. Box 111, Los Gatos	16	8S	1W	MD proj.	Franciscan rocks, Los Gatos Creek. (Herein.)
50	Los Gatos Sand & Gravel Co.	Leased to Los Gatos Sand and Gravel Co., P.O. Box 502, Los Gatos	15 or 16	8S	1W	MD proj.	Franciscan rocks, Los Gatos Creek. (Herein.)
	Martin Bros.	M.P. & B.C. Martin, San Jose (1930)	--	--	--	--	Coyote Creek, north of San Jose (Franke 30:36.)
51	Pacific Coast Aggregates, Inc. (Associated Gravel Co., Bay Development Co., Santa Clara Gravel Co.).	Pacific Coast Aggregates, Inc., 400 Alabama St., San Francisco	26	8S	2E	MD proj.	Franciscan rocks; Coyote Creek, Coyote; idle, plant removed. (Franke 30:37.)
	Prentiss Paving Co. (Raymond H. Crummey, Inc.)	Prentiss Paving Co., San Jose (1930)	--	--	--	--	Deposit near Swickart Ranch, 6 miles south of San Jose. (Franke 30:37.)
52	Piazza	Leo F. Piazza Paving Co., Route 1, Box 800, San Jose	9	8S	1E	MD proj.	Franciscan rocks, on Guadalupe Creek. (Herein.)
53	Raische	Leased by A.J. Raische, 900 San Carlos Ave., San Jose	36	7S	1E	MD proj.	Franciscan rocks; on Coyote Creek, south of San Jose. (Herein.)
	Santa Clara Gravel Co.	-- --	--	--	--	--	See Pacific Coast Aggregates, Inc.
54	Smith	Leased by L.C. Smith Co., San Mateo	16	8S	1W	MD proj.	Los Gatos Creek. (Herein.)
	Stone, E.B. and A.L.	-- --	--	--	--	--	See Coyote.

SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
55	Western Gravel Co.	J. Doetsch; leased to Western Gravel Co., Railroad Ave. and Kennedy Road, Campbell	10	8S	1W	MD proj.	Los Gatos Creek. (Herein.)
56	Western Gravel Co.	Pacific Coast Aggregates, Inc.; leased to Western Gravel Co., Railroad Ave., and Kennedy Road, Campbell	3	8S	1W	MD proj.	Los Gatos Creek. (Davis 47:367; herein.)
57	Western Tile & Supply Co.	H.W. Jensen, G.W. Wemmer, Hecker Pass road, Gilroy	2	11S	3E	MD proj.	Two miles west of Gilroy on Hecker Pass road. (Davis 47:367; herein.)

STONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Cassell	John Cassell, Los Gatos (1906)	--	--	--	--	Buff-colored sandstone on Bear Creek road, 10 miles from Los Gatos. (Aubury 06:133.)
	Flynn	-- --	--	--	--	--	Sandstone. (Crawford 94:399.)
	Gay	-- --	--	--	--	--	See Oak Hill.
	Goodrich	-- --	--	--	--	--	See Graystone.
58	Graystone	Norbert P. Pfeiffer et al., Route 3, Box 482 E, Los Gatos; and Eliza N. Santos, 2416 Homewood Drive, San Jose	22,23	8S	1E	MD proj.	Buff-colored Cretaceous sandstone quarried and used in building construction at Stanford University, San Francisco, and San Jose; worked 1866-1905. (Irelan 88:547; Watts 90:618; Crawford 94:399; Aubury 06:133; Franke 30:35.)
	Houret	Paul Houret, Route 3, Box 691, Los Gatos	1 ?	9S	1E	MD proj.	Serpentine. Used for thermo-phos fertilizer production, in 1946-48.
59	Oak Hill	Oak Hill Improvement Co., Box 224, San Jose	27,28	8S	1E	MD proj.	Gabbro and diorite mixed with serpentine. Rip-rap, coarse aggregate, and paving blocks. (Crittenden 51:64, Crawford 94:399.)
	Stanford (also see Graystone)	J. Mazzone, Route 3, Box 455, Los Gatos	15,16	8S	1E	MD proj.	Sandstone. About $1\frac{1}{2}$ miles northwest of Graystone quarry. (Irelan 88:547; Crawford 94:399; Aubury 06:133.)
	Western Granite Co.	-- --	--	--	--	--	(Crawford 94:399.)
59A	Alma	Noviatiate of the Sacred Heart, Los Gatos	SW$\frac{1}{4}$6?	9S	1W	MD	Buff-colored, friable, Vaqueros sandstone, used locally in buildings. Becomes indurated on exposure to the atmosphere. (Branner 09.)



LIST OF MINERAL DEPOSITS SHOWN ON MAP OF SANTA CLARA COUNTY

Map No.	Deposit		Sec.	T.	R.**
	CHROMITE				
1	Smith		35, 36	7S	1E*
1A	O'Connell		31	8S	3E*
	CLAY PITS				
2	Garden City Pottery	SW¼	29	6S	1E*
3	Gladding Brothers	SW¼NW¼	15	7S	1E*
4	Permanente Cement	SW¼	17	7S	2W
5	Remillard Dandini		15 16	7S	1E*
6	San Jose Brick & Tile	SW¼	24	7S	1W
	COPPER				
6A	Hooker Creek		10	9S	1W*
	LIMESTONE				
7	Bernal		19	8S	2E*
8	Douglas Ranch	SW¼NW¼	27	8S	1W
9	Lyndon	SE¼	28	8S	1W
10	Permanente Cement		18	7S	2W
	MAGNESITE				
11	Western		18 19	6S	5E
	MANGANESE				
12	Black Eagle	SE¼	28	6S	5E
13	Black Horse	NE¼	32	6S	5E
14	Cottonwood	SW¼	28	6S	5E
15	Jones	NW¼	27	6S	5E
16	Keller (Dead Oak)	NW¼	32	6S	5E
17	Mumac	SW¼	21	6S	5E
18	Pine Ridge		31	8S	4E
19	Queen Bee	SW¼	29	6S	5E
20	Winegar		19	5S	4E
	QUICKSILVER				
21	Comstock		19	11S	7E
22	Enriqueta		33	8S	1E*
23	Guadalupe		30	8S	1E*
24	Hillsdale		28 33	7S	1E*
25	New Almaden	N½	3	9S	1E*
26	New Almaden Placers (Dump)	SE¼	2	9S	1E*
27	New North Almaden		5	8S	2E*
28	R[illegible]nda	NE¼	22	10S	4E
29	Santa Teresa		24	8S	1E*
30	Senator	W½	29	8S	1E*
31	Silver Creek		33	7S	2E*
	ROCK (crushed)				
32	Anderson Lake		10	9S	3E*
33	Bihr and Ledoyen		26	6S	3W*
34	Commercial Materials		22	7S	2W
35	County (Alum Rock)		23	6S	1E
36	County (Saratoga)		11	8S	2W
37	Fredrickson Watson (Winterbower)		4	6S	1E*
38	Lone Hill		7 18	8S	1E*
39	Piazza (Alum Rock)		23	6S	1E*
40	Piazza (Stevens Cr.)		21 or 22	7S	2W
41	Rhodes & Robinson (Stanford)		23	6S	3W
42	Reegasch Bros	NW¼	6	6S	1E*
43	Senator Dump		29	8S	1E*
44	Sondgrath Bros. (Neary)		6	7S	2W*
45	Voss		28	7S	2W
	SAND AND GRAVEL				
46	Brem Bros		1	11S	3E*
47	County (Gilroy)		1	11S	3E*
48	County (San Martin)		11 or 12	10S	3E*
49	Los Gatos Construction		16	8S	1W*
50	Los Gatos Sand & Gravel		15 or 16	8S	1W*
	SAND AND GRAVEL (continued)				
51	Pacific Coast Aggregates		26	8S	2E*
52	Piazza (Guadalupe Cr.)	NW¼	9	8S	1E*
53	Raische		36	7S	1E*
54	Smith		16	8S	1W*
55	Western Gravel (Doetsch)		10	8S	1W*
56	Western Gravel (PCA)		3	8S	1W*
57	Western Tile & Supply		2	11S	3E*
	STONE				
58	Greystone		15 22	8S	1W
59	Oak Hill		27 28	7S	1E*
59A	Alma	SW¼	6 (?)	9S	1E*

* Projected
** Mt. Diablo Base & Meridian

EXPLORATORY WELLS DRILLED FOR OIL

(Plotted in center of section)

Map no.	T.	R.	Sec.	B.M.	Company	Well	Year drilled	Depth (feet)	Geology
60	8S	1W	9	MD	Crossen, Carl	No. 1	1929	615	Bottomed in Miocene?
61	8S	1W	10	MD	Traders Oil Corp.	T 1	1918	2006	Bottomed in Miocene
62	8S	1E	7	MD	Tinnely, Alfred	No. 1	1927	2356	
63	9S	1W	5	MD	F. C. Farby and L. C. Bowles	Idylwild 1	1951	255	
64	9S	1W	8	MD	Norris, A. R.	Logan 1	Pre-1938	1100	
65	9S	1W	8	MD	Norris, A. R.	Logan 2	Pre-1938	1500	
66	9S	1W	8	MD	Strader Oil Co.	Strader 2	1930	2300	
67	9S	1W	8	MD	Madrone Oil Co.	No. 1			
68	9S	1W	9	MD	Los Nietos Company	Holy City 1	1951	4659	
69	9S	1E	8	MD	Trigonia Oil & Gas Co.	Trigonia 5	Pre 1925	612	Bottomed in Monterey
70	11S	4E	1	MD	Traders Oil Corp.	Rasmussen 2	1918	2675	Bottomed in Miocene

GEOLOGIC MAP OF SANTA CLARA COUNTY, CALIFORNIA, SHOWING MINES AND MINERAL DEPOSITS

Geology modified after Allen, Bailey, Bodenlos, Branner, Newsom and Arnold, Crittenden, Frames, Gilbert, Leith, Ortalda, Taliaferro, Thomas

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

Volume 50, Numbers 3 and 4
JULY-OCTOBER 1954

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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

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DEPARTMENT OF NATURAL RESOURCES
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DIVISION OF MINES
OLAF P. JENKINS, Chief

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Branch Offices
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The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles, Sacramento and Redding branch offices.

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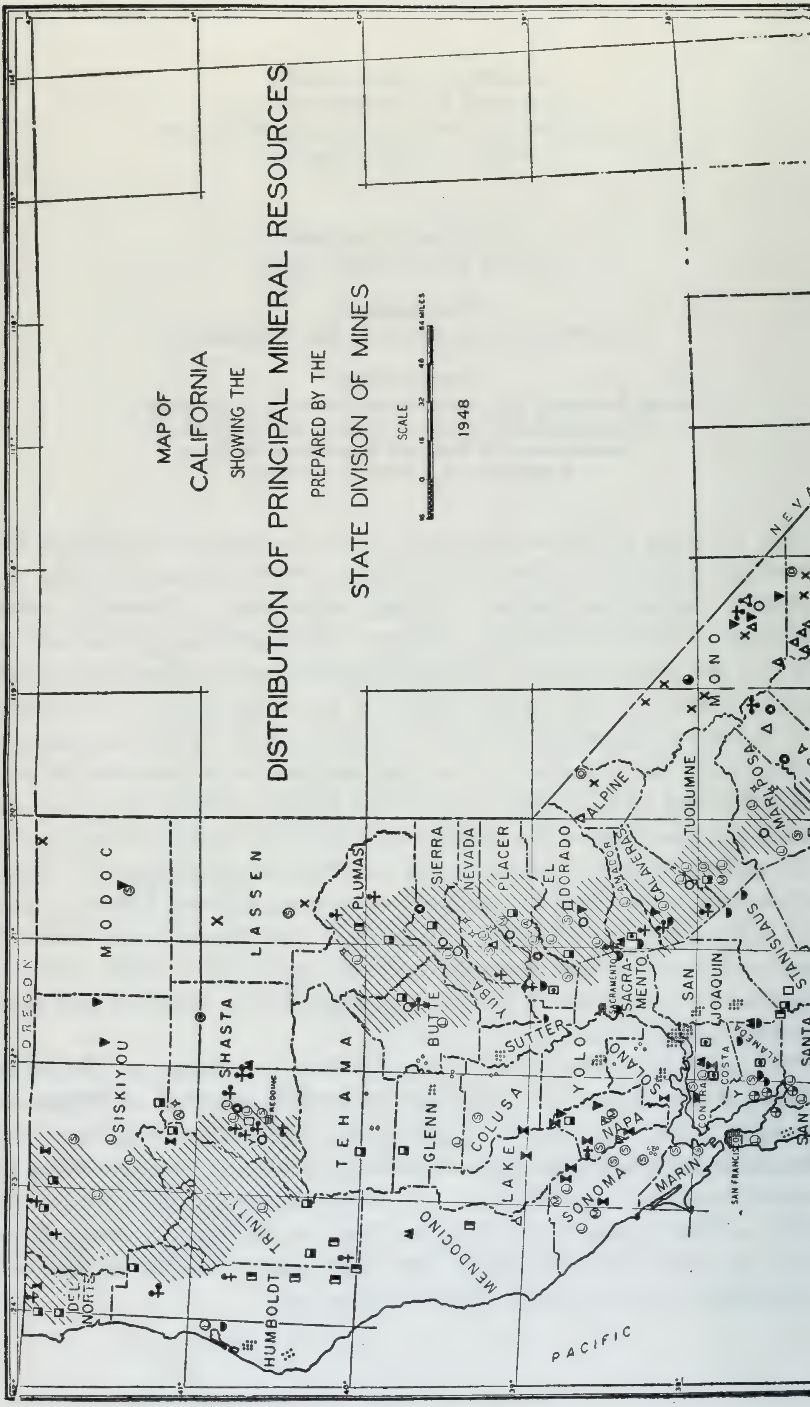
MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
1948
OREGON
NEVADA
PACIFIC
MODOC
SISKIYOU
DEL NORTE
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
PLACER
YUBA
SUTTER
COLUSA
MENDOCINO
LAKE
YOLO
EL DORADO
ALPINE
AMADOR
SACRAMENTO
SACRA-
MENTO
CALAVERAS
SONOMA
NAPA
SOLANO
MARIN
SAN FRANCISCO
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
MARIPOSA
STANISLAUS
ALAMEDA
SANTA
SAN

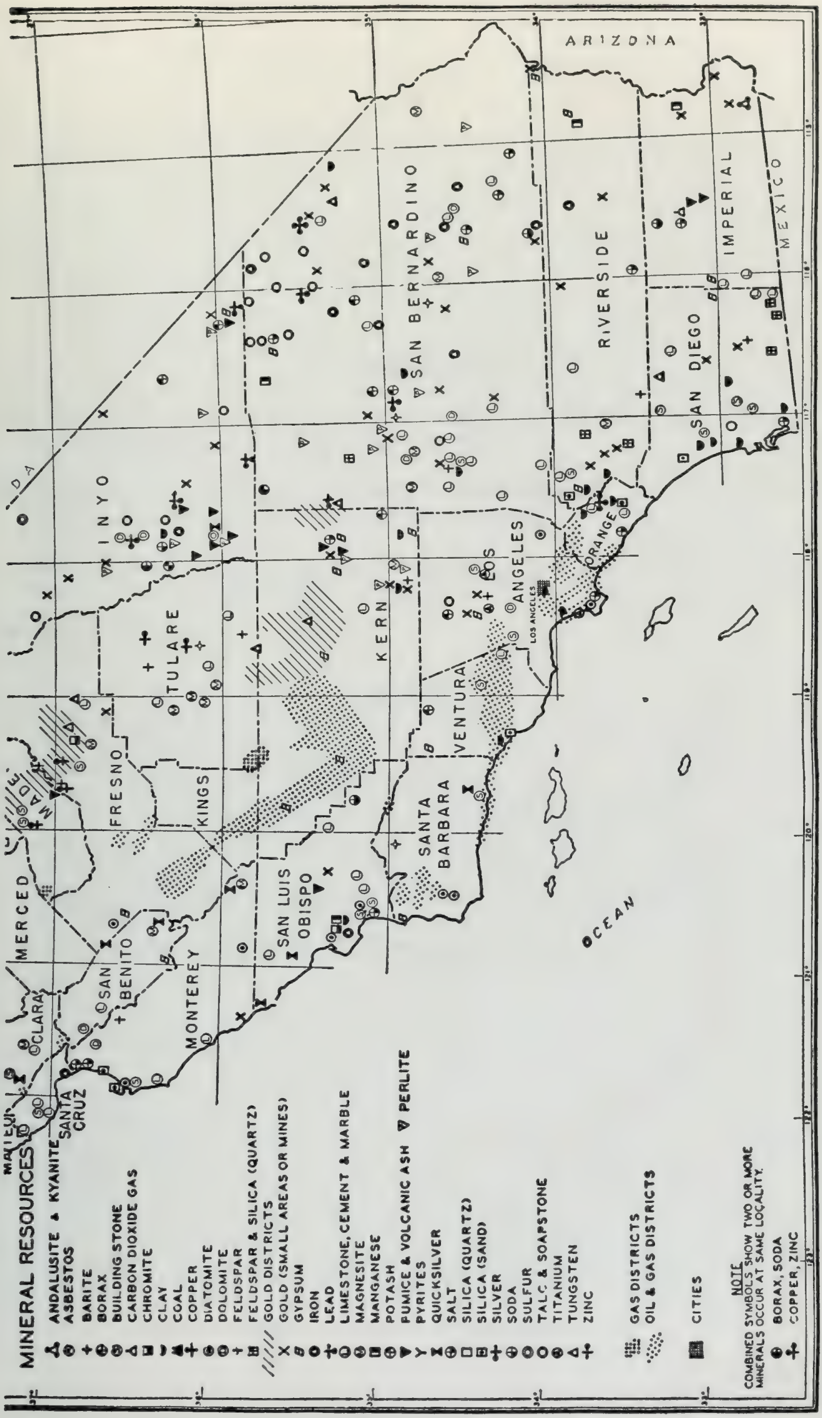
MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
ARIZONA
MEXICO
OCEAN
INYO
SAN BERNARDINO
RIVERSIDE
IMPERIAL
SAN DIEGO
ORANGE
LOS ANGELES
LOS ANGELES
KERN
TULARE
FRESNO
KINGS
MADERA
MERCED
SAN BENITO
MONTEREY
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
SANTA CLARA
SANTA CRUZ
MATEO

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Plate 3. Geologic map of the Cool-Cave Valley area showing location of limestone deposits ... In pocket

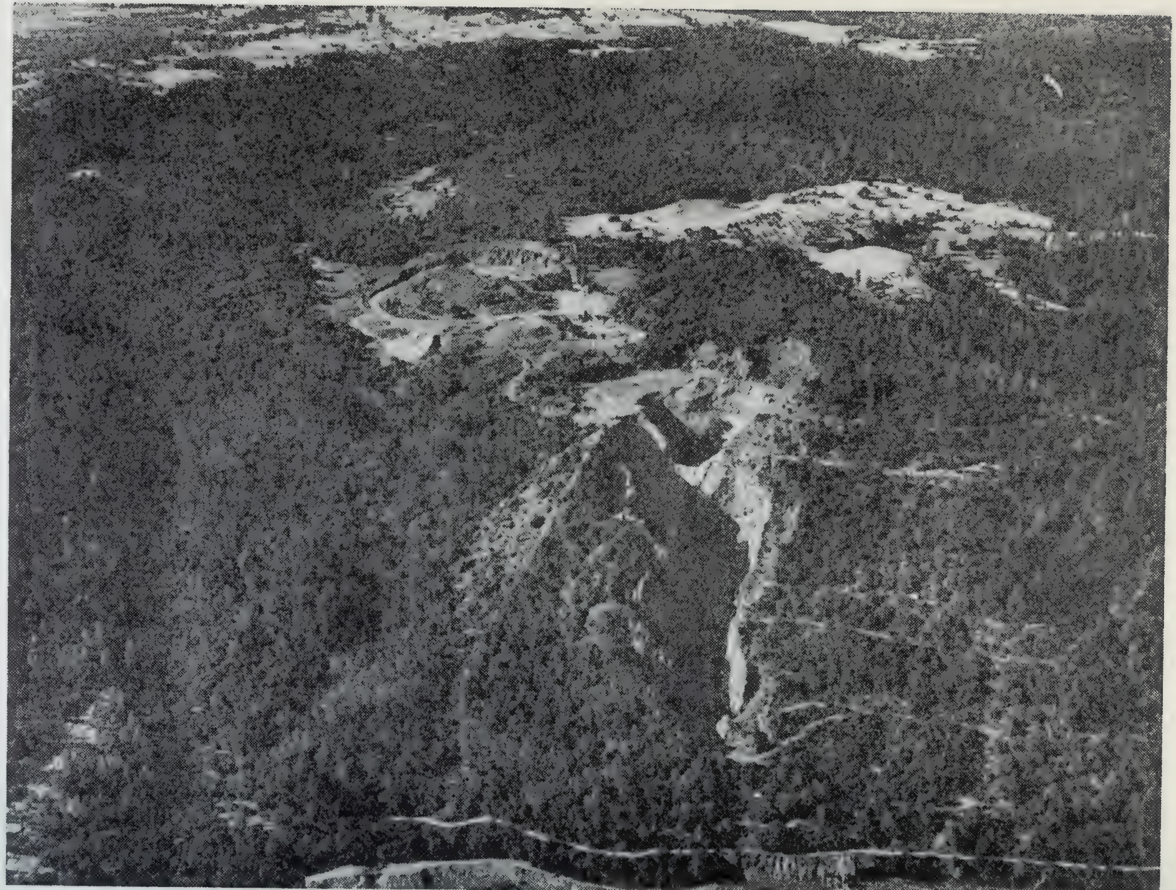
4. Geologic map of Los Angeles County ... In pocket

5 and 6. Map of Los Angeles County showing mines, mineral product locations, and all field producing zones ... In pocket

7. Map of Angeles National Forest showing lands not open to mining ... In pocket

8. Location map to accompany shaded relief map of the Los Angeles area ... In pocket

Shaded relief map of Los Angeles area ... In pocket



FRONTISPIECE. Aerial view of Cool-Cave Valley limestone deposits, camera facing south. Mountain Quarries of the Pacific Portland Cement Company in the foreground, quarry of the California Rock and Gravel Company in middle-ground. Cave Valley and ad'acent gulches are roughly aligned parallel to the regional structure which is slightly north of west. ***Photo courtesy California Rock and Gravel Company.***

THE COOL-CAVE VALLEY LIMESTONE DEPOSITS, EL DORADO AND PLACER COUNTIES, CALIFORNIA

By William B. Clark *

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ABSTRACT

The Cool-Cave Valley limestone deposit consists of two elongate lenses extending in northerly direction through the Sierran foothills about 4 miles east of Auburn, California. Limestone has been quarried from both lenses. Mountain Quarries, at the north end of the deposit, was one of the chief sources of limestone in northern California from 1910 to 1930. The California Rock and Gravel Company now operates a quarry for the production of limestone for use in sugar refineries in

* Junior Mining Geologist, California Division of Mines.

the central portion of the deposit adjacent to the idle Mountain Quarries.

The geologic structure of the area has a north to northwest trend. In the area immediately surrounding the limestone, the rock is composed of dynamothermally metamorphosed fine-grained basic volcanic rocks commonly called greenstone, of undetermined age. To the west and north of the limestone are extensive beds of Carboniferous metamorphosed marine sediments and masses of amphibolite. Both the limestone and the volcanic rocks are cut by dikes of medium-grained quartz diorite and diorite porphyry. The exact relationship of the limestone with the other rocks of the area is not clear.

The limestone deposit is $1\frac{3}{4}$ miles long and averages 400 feet in width. The limestone has been partially to completely recrystallized and is characterized by prominent jointing, a firm and tenacious texture, and a bluish-gray color. Analyses made of a number of samples show it to be a high-calcium limestone containing between 97 and 99 percent calcium carbonate.

At Mountain Quarries, limestone was quarried by the glory hole method. From the quarry it was trammed through an adit to the crushing plant. Most of the stone was then shipped via railroad to the Pacific Portland Cement Company plant. After 1930 production was largely used in beet sugar refineries. Peak production varied from 1200 to 1500 tons per day.

Since 1946, the California Rock and Gravel Company has operated a quarry in the central portion of the deposit. The ''coyote hole'' method of quarrying is employed, whereby an entire year's production of 150,000 tons is dislodged in one blast. The rock is then run through a crusher and a sizing plant. Coarser sizes are shipped via railroad to beet sugar refineries while the finer material is trucked to a lime plant near Rattlesnake Bridge or sold as road metal. Estimated reserves of the entire deposit are 18,225,000 tons per 100 feet of depth.

A number of smaller limestone deposits are in the general area of the Cool-Cave Valley deposit, the most important being the Rattlesnake Bridge deposit 10 miles to the southwest. Many of the other limestone deposits of the area are interbedded with metasediments.

INTRODUCTION

Approximately 4 miles east of Auburn, California is the Cool-Cave Valley limestone deposit. The deposit consists of two elongate limestone lenses extending from a point half a mile north of the town of Cool, El Dorado County, north for a distance of approximately $1\frac{3}{4}$ miles to just north of the Middle Fork of the American River in Placer County. The two lenses lie in secs. 6 and 7, T.12N., R.9E., M.D.M. The bulk of the deposit is in El Dorado County.

The Cool-Cave Valley area is traversed by State Highway 49 which crosses the south end of the deposit. Dirt roads branching off Highway 49 give access to nearly all parts of the limestone deposit. The nearest railroad is the main line of the Southern Pacific which runs through Auburn in a northeasterly direction. Until 1942, Mountain Quarries of the Pacific Portland Cement Company at the north end of the deposit on the Middle Fork of the American River, was served by a company-owned railroad which connected with the Southern Pacific at Auburn. The old railroad right-of-way is now a dirt road.

FIGURE 1. Ruins of old lime kiln at the south Cool-Cave Valley deposit on the east side of State Highway 49. *Photo by Mary R. Hill.*

Topography of the region is characterized by steep-walled canyons and moderately steep peaks. Elevations vary from 500 to 1800 feet. The topography and drainage pattern is partly controlled by the north to northwest trend of the major geologic structures. As the Sierra Nevada has been tilted in a general southwesterly direction, the main rivers and stream flow in that general direction, while the small tributaries tend to flow to the northwest or southeast in response to the structure.

HISTORY

Limestone has been quarried at both of the lenses. Lime was produced in the early history of the operations by burning the limestone with wood in stone lime kilns. During the 1880's, the Cave Valley deposit was operated by the firm of Davis and Cowell (Hanks, 1884). In 1894 the Cave Valley Lime Company produced 150 to 160 tons of lime per month during the summer from two kilns which were located alongside of the Auburn-Cool road (Crawford, 1894). Ruins of these old kilns may be seen today north of Cool close to State Highway 49.

In 1910 the Pacific Portland Cement Company opened its Mountain Quarries on the south side of the Middle Fork of the American River for the production of limestone for use in the company-owned cement plant in Solano County (Logan, 1947, p. 232). From 1910 until about 1930 this quarry was one of the chief sources of limestone for the cement, sugar, and steel industries in northern California. After 1930 production was smaller, the cement plant in Solano County having been idle part of the time. In 1942 the quarry was shut down, and the

FIGURE 2. Old limestone quarry in the south Cool-Cave Valley deposit; view north from State Highway 49.

railroad and crushing plant were dismantled. Since that date, it has been idle.

In 1946 the central portion of the northern lens, just south of Mountain Quarries, owned by the Henry Cowell Lime and Cement Company, 2 Market Street, San Francisco, was leased to the California Rock and Gravel Company, 1800 Hobart Building, San Francisco (Logan, 1947, p. 225). At the present time this firm operates a quarry at this site for the production of limestone, which is used chiefly in sugar refineries.

GENERAL GEOLOGY

The general trend of the rock units is north to northwest. The rocks of the region consist of a series of dynamothermally metamorphosed marine sediments of the Calaveras group and metavolcanic rocks, some of which probably belong to the Calaveras group and some of which probably do not.

The Calaveras group, of which the limestone has been considered as part, makes up the bulk of the Paleozoic part of the bedrock of the Sierra Nevada. For a long time the Calaveras group was considered to be Carboniferous in age; however, recent work has caused a number of investigators to believe that it includes a greater part of the Paleozoic section than just the Carboniferous (Taliaferro, 1943, p. 280). Stratigraphic relations of the limestone with other members of the Calaveras group are not clear in many areas.

Rock Units

Metavolcanic Rocks. In the immediate area of the Cool-Cave Valley limestone, the enclosing rock consists chiefly of metamorphosed volcanic rocks, green schist and massive unlaminated greenstone being the most abundant. Moderately resistant as compared with the other rocks of the region, the greenstone occurs in bold massive outcrops. Massive blocky greenstone is most common east of the Cool-Cave Valley limestone whereas green schist is common to the west. Green schist is well exposed in road cuts in the vicinity of the State Highway 49 bridge over the Middle Fork of the American River.

FIGURE 3. Mountain Quarries 1953; view south across the Middle Fork of the American River. *Photo by Mary R. Hill.*

Where fresh, the massive greenstone is dull green to greenish-brown while the green schist is brilliant green. Both weather readily, first to a dull red or brown and then to a red soil.

The greenstone and green schist have apparently been derived from a series of fine-grained basic volcanic rocks, many of them tuffaceous. They are composed chiefly of chlorite with varying amounts of epidote, actinolite-tremolite, plagioclase, hornblende, zoisite, and smaller amounts

FIGURE 4. Mountain Quarries on the Middle Fork of the American River as seen from the Auburn-Forest Hill road in 1940 showing crushing plant and loaded train. *From a photo by Alfred L. Ransome.*

of iron oxide and pyrite. Calcite is sometimes present in veinlets and cavities. Porphyroblastic textures are common.

Amphibolite. Two miles west of the Cool-Cave Valley limestone is a 2000-foot-wide bed of hornblende-plagioclase amphibolite. It is massive to schistose and varies from a light-colored plagioclase-rich variety to a dark-green variety composed chiefly of hornblende.

Cutting across the limestone in the north end of Mountain Quarries at a small angle to the elongation of the lens is a 45-foot wide dikelike mass of dark grayish-green rock containing numerous amygdules of white calcite. It is badly-sheared porphyritic amygdaloidal basalt composed of calcite amygdules and pseudomorphs of intermeshed calcite and relict plagioclase set in a dark fine-grained groundmass of chlorite and iron oxide.

Diorite Porphyry. Both the limestone and the metavolcanic rocks in the vicinity of the limestone have been intruded by a number of diorite porphyry and quartz diorite porphyry dikes. They cut the limestone and metavolcanic rocks at small-angles both in dip and strike. The dikes are light to medium gray in color and are composed of phenocrysts of plagioclase and altered hornblende in a dense fine-grained groundmass of plagioclase, epidote, chlorite and iron oxide. Quartz may or may not be present. Much secondary calcite and usually small amounts of pyrite are present.

Serpentine. Serpentine is widely distributed throughout the area. The largest serpentine body in this region crops out for about 1500 feet along an old railroad right-of-way on Robie Point in eastern Auburn. It is derived from basic intrusive rock, both the olivine and

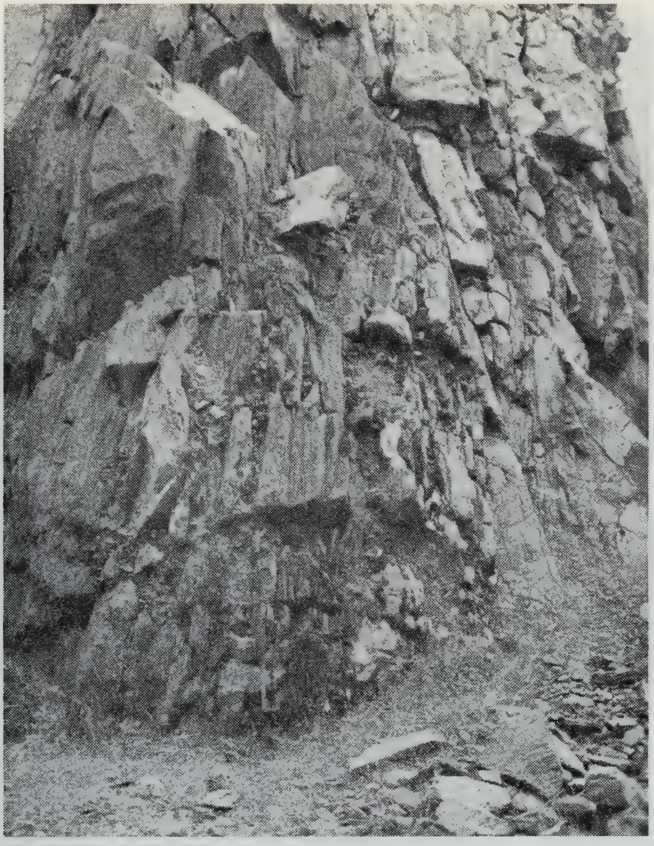

FIGURE 5. Contact between limestone and a mass of amygdaloidal basalt that cuts across the limestone in the north end of Mountain Quarries.

pyroxene having been altered to light and dark serpentine. There are many small serpentine bodies in the vicinity of the limestone, which have been altered to light iron oxide-stained talc.

Metasedimentary Rocks. Metasedimentary rocks of the region include slate, chert, sheared sandstone and conglomerate, and limestone. All of the metasediments in the general area of the Cool-Cave Valley deposit have been considered to be part of the Calaveras group by Lindgren (1894). The Clipper Gap formation, part of the Calaveras group named by Lindgren, crops out in the southwestern portion of the adjoining Colfax quadrangle and is an extension of the series of metasediments in this area.

Chert in this area varies from light to dark gray in color and is in places stained black with manganese oxide. The chert occurs in thin lenticular beds that are often contorted near the surface. Slate occurs in irregular beds and varies from a grayish cherty variety to a nearly black clayish variety. Also present in appreciable amounts are argillaceous sandstone, arkosic sandstone and fine- to coarse-grained conglomerate, all of which have undergone varying degrees of shearing.

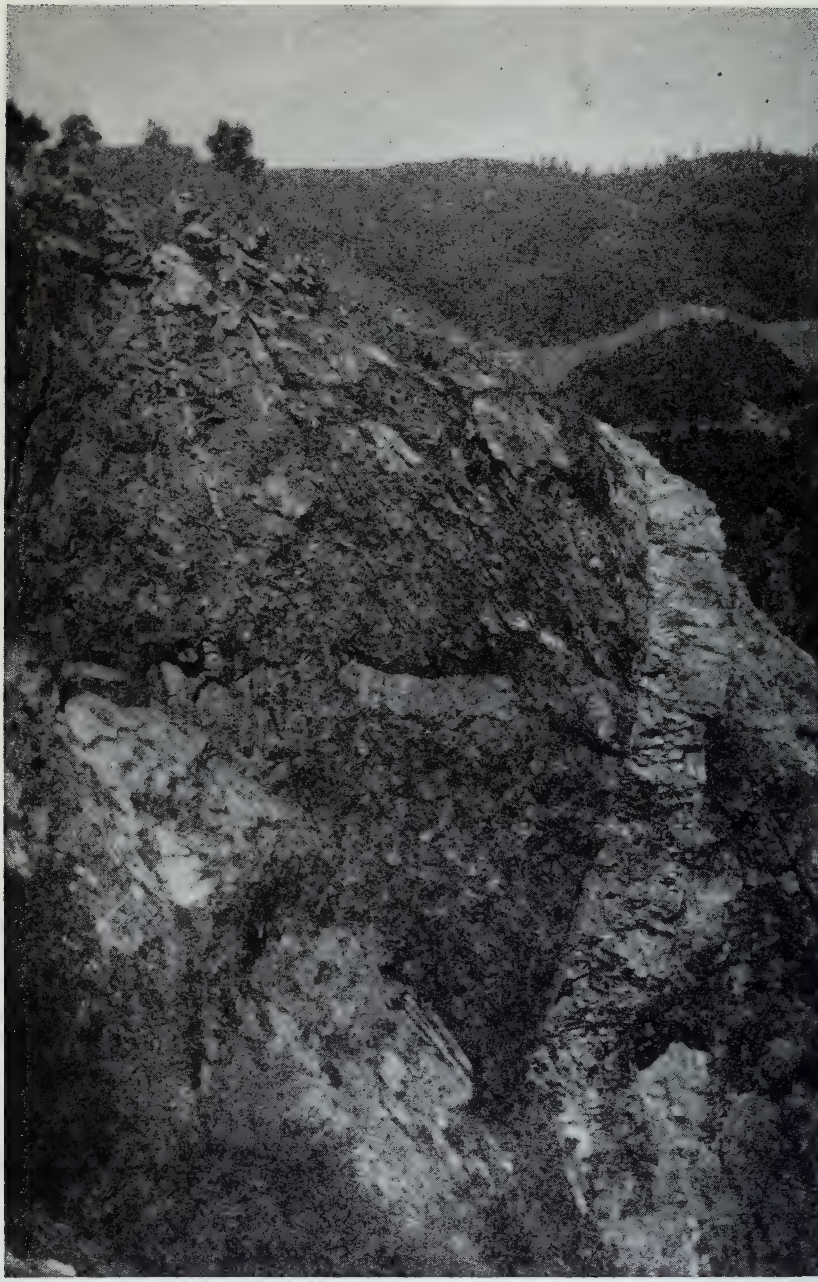

FIGURE 6. Quartz diorite porphyry dikes cutting limestone in Mountain Quarries; camera facing north toward the Auburn-Forest Hill road.

A wide belt of these metasediments is exposed along the Southern Pacific Railroad 3 miles to the north of the Cool-Cave Valley limestone deposit. A branch of this belt extends south to just east of the State Highway 49 bridge over the Middle Fork of the American River about one mile west of the limestone. Another wide belt of metasediments, which joins those to the north, extends in a general northwest direction about 2 miles east of the limestone.

Regional Geologic Structure

Structure sections accompanying the U. S. Geological Survey folios that cover El Dorado and Placer County published during the period 1890-1900 indicate a regional homoclinal relationship of the stratified rocks of the basement complex. Taliaferro (1943 pp. 285-286) in his studies along the Cosumnes River, which lies less than 30 miles south of the Cool-Cave Valley limestone, has demonstrated that the relationships are far more complex and that the stratigraphy is complicated by large and small isoclinal folds and by major faults. Although detailed mapping on a regional scale was beyond the scope of this study, mapping of several strips across the regional trend of the formations indicated that similar structural conditions exist in the Cool-Cave Valley vicinity. Although slaty cleavage, schistosity and often major joint patterns tend to be parallel to the bedding in stratified rocks of the region, the relationship does not hold at crests and troughs of folds; cleavage and schistosity tend to be much more prominent than bedding. Interpretation of structure is further complicated by a lack of continuous distinctive beds and by a lack of time markers.

COOL-CAVE VALLEY LIMESTONE

The two large lenses comprising the Cool-Cave Valley deposit extend in a north direction for a distance of approximately 1¾ miles.

The large northern lens, which is crossed by the Middle Fork of the American River at the northern end, is about 5500 feet long and averages 400 feet in width. Diamond drilling done by the Pacific Portland Cement Company showed this lens to extend to a depth of at least 800 feet below the original land surface of Mountain Quarries (Tucker, 1916). The southern lens, which is crossed by State Highway 49, is 2000 feet long and nearly 600 feet wide in the middle.

Being relatively resistant to erosion, the limestone stands out prominently from the surrounding metavolcanic rocks. The limestone is partially to completely recrystallized and is dense and tenacious. When fresh it is dark bluish gray to almost black in color. When weathered, it is light bluish gray. The limestone is generally even-grained, the individual crystals varying from 1 to 3 mm in diameter. A fetid odor of hydrogen sulfide is emitted when a fresh surface is hammered. Chemical weathering is most prominent along the joints. Small solution caves containing coarse crystalls of secondary aragonite are common along joints in the limestone.

Although much of the limestone is completely recrystallized, a small amount of fossil debris was found in the southeast corner of Mountain Quarries. The debris is composed partly of coral and crinoid fragments of indeterminate age. Small amounts of pyrite are present in the limestone with the fossil debris.

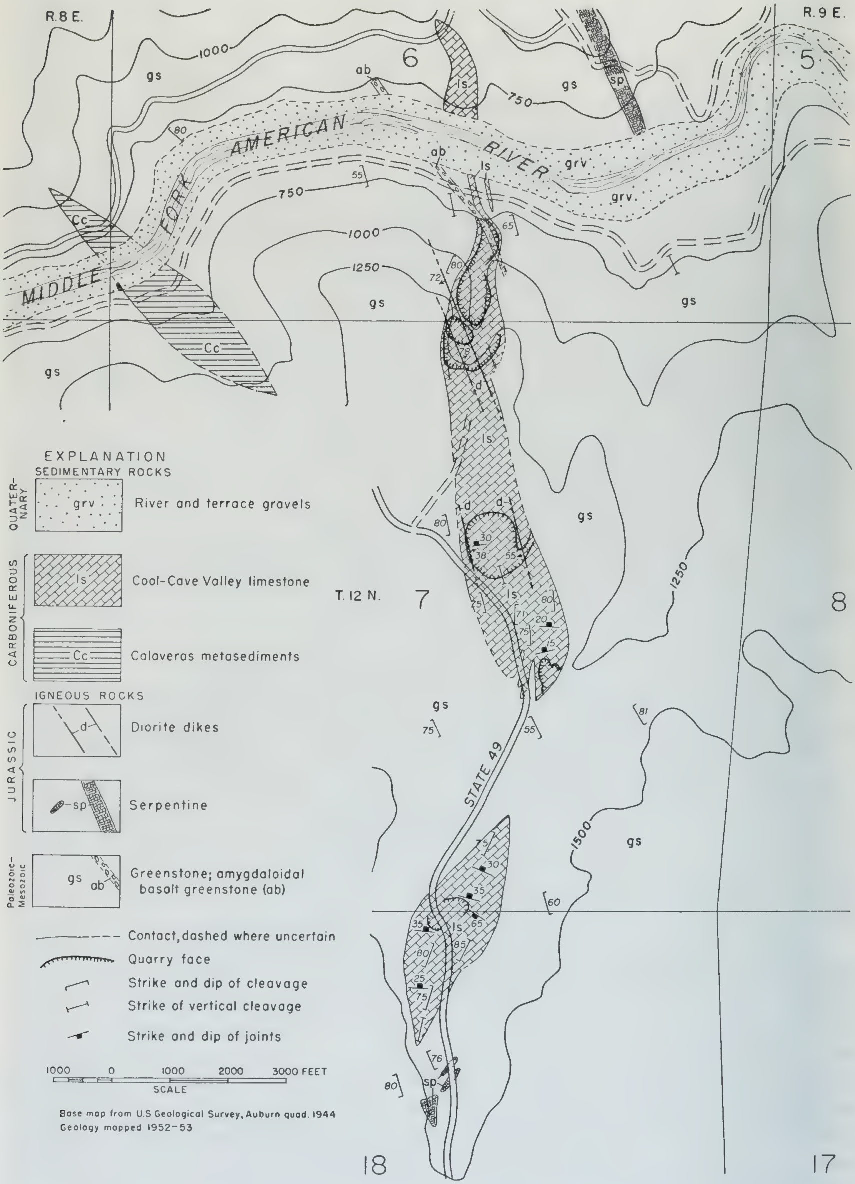

FIGURE 7. Geologic map of the Cool-Cave Valley limestone.

FIGURE 8. North end of Mountain Quarries, camera facing north. To left a dikelike mass of amygdaloidal basalt crosses the limestone mass. To right, grooves in limestone give a fluted appearance.

A considerable part of the Cool-Cave Valley limestone mass was originally composed of organic debris, much of it being of crinoid and coral fragments. Part of the mass may have been chemically precipitated. The original source of calcium carbonate may have been volcanic in part as suggested by the almost universal association of limestone with metavolcanic rocks in this area.

At the north end of Mountain Quarries some of the exposed surfaces of the limestone have a fluted appearance which is caused by a series of parallel grooves varying from one to several feet apart and one to several inches in depth. These grooves are parallel to the strike and were apparently formed on slip surfaces.

Structure of the Limestone

Strike of bedding and schistosity in the northern lens varies from north to N. 15° W. Dip is both to the east and west and ranges from 75 degrees to vertical. Parallel jointing is prominent. The joint planes of the principal series of joints are 1 to 15 feet apart and have a strike nearly perpendicular to that of the bedding. Dip of the joints is north and ranges from 20 to 35 degrees. Secondary joints if present, are either parallel to the strike of the bedding or are perpendicular to the bedding and dip south.

Bedding and schistosity of the southern lens strike approximately N. 15° E. and dip 75 to 85 degrees northwest. As in the northern lens, joints are nearly perpendicular to the strike of the bedding and schistosity and dip 20 to 35 degrees northeast.

No definite conclusion can be reached in regard to the precise position of the limestone lenses in the stratigraphic sequence or to the exact

FIGURE 9. Jointing in the limestone in Mountain Quarries.

FIGURE 10. Jointing in the limestone in the south Cool-Cave Valley deposit.

structural relationship between the limestone and the enclosing rocks. However, several interpretations are possible based on the following observations:

1. In some places differential movement between the limestone and the enclosing greenstone is plainly indicated; in others there is no evidence of differential movement. In places where there have been differential movements their magnitude cannot be measured. In and adjacent to the glory hole at Mountain Quarries, a quartz diorite dike cuts diagonally across the limestone-greenstone contact. It has not been displaced at the contact showing that any movement which might have taken place along the contact would have occurred prior to the emplacement of granitic rocks in Upper Jurassic time.

2. The Cool-Cave Valley deposits are bordered entirely by greenstone as are several smaller lenses exposed along the Forest Hill road and elsewhere in the area. Other limestone lenses in the general area are bordered entirely or partly by other metasediments such as slate, mica schist, meta chert, etc.

3. The Cool-Cave Valley limestone bodies occupy a median position between two belts of metasediments. One and a half miles northwest of the deposits along the canyon of the North Fork of the American River, metasediments of the Clipper Gap formation are interfolded with greenstone. The areal distribution of the wedge-shaped salients, as seen on the accompanying map, strongly suggests a succession of steeply pitching, large-scale isoclinal folds. This relationship is well seen on a smaller scale in roadcuts along the south side of the North Fork Dam road in the extreme northwest corner of sec. 1, T. 12 N., R. 8 E., M.D.B. and M. There, metavolcanics are stratigraphically below metasediments in the crest of an anticline.

4. At the north end of Mountain Quarries the limestone is crossed by a tabular mass of sheared, altered, amygdaloidal, basic volcanic rock similar in character to some facies of the enclosing greenstone. The amygdaloidal mass transgresses slightly the regional trend of the limestone lens south of the American River and north of the river a similarly trending mass is found a few feet within the enclosing greenstone. The amygdaloid has obviously been deformed with the limestone prior to emplacement of the dioritic dikes.

Three possible structural interpretations are:

1. If the displacement along the contact between the limestone and greenstone is interpreted as having been of great magnitude, then the limestone could have reached its present position by major faulting, plastic flow or a combination of both prior to Upper Jurassic time.

2. If displacement along the contact and presence of isoclinal folding are discounted as being of minor importance only and the stratigraphic sequence is interpreted as homoclinal as shown on the folios, then the limestone could be interpreted simply as a lenticular member interbedded with the enclosing greenstone.

3. The relative position of the limestone lenses with respect to the position of the greenstone and the Calaveras group metasediments suggests a major structure with the limestone lenses lying roughly along the axis of that structure. However, since the relative ages of the greenstone, Calaveras group, and limestone are uncertain, judgment of such a structure as anticlinal or synclinal is not possible.

Analyses of the Limestone

Nearly all of the limestone in the Cool-Cave Valley deposit is high in calcium carbonate and low in magnesium carbonate. A total of 45 samples were taken from both lenses. Samples of fresh limestone, varying from 2 to 4 pounds in weight, were taken at regular intervals across the strike of the lenses and several composite samples of small chips were taken along the margins of the southern lens.

All but one of the eleven samples taken from the north portion of the north lens north of the Middle Fork of the American River contained more than 98 percent calcium carbonate. Three of the eleven samples contained slightly more than 1 percent while the other eight contained less than 1 percent magnesium carbonate.

Many samples were taken in Mountain Quarries, both from along the margins of the lens and from near where the limestone is cut by diorite porphyry dikes and amygdaloidal basalt. Other than two samples taken next to the limestone-amygdaloidal basalt contact, which ran slightly over 90 percent calcium carbonate and about 5.5 percent insoluble material, all others varied from about 96.4 to 98.6 percent calcium carbonate, .5 to 1.6 percent magnesium carbonate and 1 percent or less insoluble. Five samples taken across the strike at the southern end of the north lens averaged 97.6 percent calcium carbonate and 1.1 percent magnesium carbonate.

The following are analyses supplied by the California Rock and Gravel Company of four limestone samples from lots shipped from their quarry in the central portion of the north lens.

Sample	SiO_2	R_2O_3	$MgCO_3$	$CaCO_3$
1	.30	.72	.78	98.17
2	.48	.52	.24	98.76
3	.36	.22	.26	99.16
4	.24	.16	.73	98.87

Five samples taken across the north end of the south lens averaged 96.8 percent calcium carbonate and 0.77 percent magnesium carbonate. Sample number 10, a composite sample taken along the northwest margin of the lens which contained 93.8 percent calcium carbonate and 4.6 percent insoluble material, is not believed to be truly representative of the deposit as the limestone is deeply weathered in this part of the deposit. Four samples taken from the southern end of the south Cool-Cave Valley deposit averaged 97.1 percent calcium carbonate and 1.2 percent magnesium carbonate.

FIGURE 11. North end of the Cool-Cave Valley deposit on the north side of the Middle Fork of the American River; camera facing north.

In general, the deposit is nearly uniform in composition. There are no noticeable changes in composition across the strike of the lenses. Apparently, there has been very little contamination from outside sources. Except in a few places at the extreme outer edge of the lenses and where the limestone has been deeply weathered, composition of the deposit is 97 to 99 percent calcium carbonate.

Quarrying and Milling Operations

Limestone at Mountain Quarries was quarried by the glory hole method. Three glory holes were connected by raises from an 1800-foot south-extending adit. The adit entered the hillside at a point about 70 feet above the river. The glory holes have vertical sides and have been worked to a depth of about 600 feet. Limestone was quarried to within a few feet of the edge of the lens. This practice prevented the walls from caving as the limestone is much more rigid and tenacious than the surrounding volcanic rocks. The parallel joints in the limestone were an aid in quarrying operations.

Overburden was removed by steam shovels. Stone was then blasted from the quarry faces, dumped down the raises to chutes and then to 6-ton cars in the adit. The cars were then trammed out the adit to the crushing and sizing plant. Before crushing, it was hand-sorted to remove the dike rock and other foreign material. The stone was then

Tabulated list of analyses of samples. Locations are plotted on the sample map. Analyses by Abbot A. Hanks, Inc., 624 Sacramento Street, San Francisco, California.

Sample	Insoluble	R_2O_3	P_2O_5	$MgCO_3$	$CaCO_3$
1	1.18	.32	.06	1.08	97.35
2	.70	.26	.06	1.84	97.14
3	.52	.18	.04	.72	98.54
4	2.50	.62	.08	1.32	95.48
5	.70	.44	.21	.86	97.79
6	2.38	.54	.20	.65	96.23
7	2.42	.38	.17	.78	96.25
8	1.02	.64	.30	.76	97.28
9	.74	1.06	.59	.84	96.77
10	4.62	.48	.16	.91	93.83
11	.64	.28	.08	1.46	97.64
12	.34	.24	.04	.86	98.52
13	1.12	.34	.06	.99	97.49
14	1.18	.30	.11	1.67	96.74
15	.82	.36	.11	.78	97.93
16	4.92	2.14	.16	1.98	90.80
17	.54	.41	.22	.69	98.14
18	.36	1.04	.36	.77	97.47
19	.58	.74	.11	.77	97.80
20	1.38	.84	.23	1.11	96.44
21	1.16	.44	.12	1.33	96.95
22	.36	.26	.08	.89	98.41
23	.68	.24	.07	1.18	97.83
24	5.56	1.78	.08	1.67	90.91
25	.92	.56	.07	.70	97.75
26	.84	.48	.11	.68	97.89
27	.78	.26	.15	.46	98.35
28	.36	.64	.28	.59	98.15
29	5.56	2.26	.20	1.62	90.36
30	.46	.28	.13	.52	98.61
31	.66	.44	.14	.59	98.15
32	.42	.22	.13	.87	98.36
33	1.28	.52	.21	1.12	96.87
34	.48	.20	.18	.59	98.55
35	.26	.16	.15	.70	98.73
36	.34	.48	.28	.83	98.07
37	.26	.24	.20	1.20	98.10
38	.26	.32	.15	1.05	98.22
39	.24	.20	.15	.50	98.91
40	.46	.16	.16	.60	98.62
41	.48	.66	.25	.22	98.39
42	.42	.18	.21	.70	98.49
43	.28	.28	.16	.81	98.47
44	1.18	.58	.15	1.21	96.88
45	.38	.34	.15	.58	98.54

fed to a gyratory rock crusher and then to trommels where it was washed and sorted. It was conveyed to railroad cars and shipped over a seven-mile company-owned railroad to Auburn.

Three sizes; 2½-inch, plus 2½-inch minus 4-inch, and plus 4, minus 8-inch were produced. The 2½-inch rock was shipped to the Pacific Portland Cement Company cement plant in Solano County while the coarser sizes were shipped to sugar refineries (Young, 1925). Peak production varied from 1200 to 1500 tons of limestone per day. About 140 men were employed at the quarry and plant.

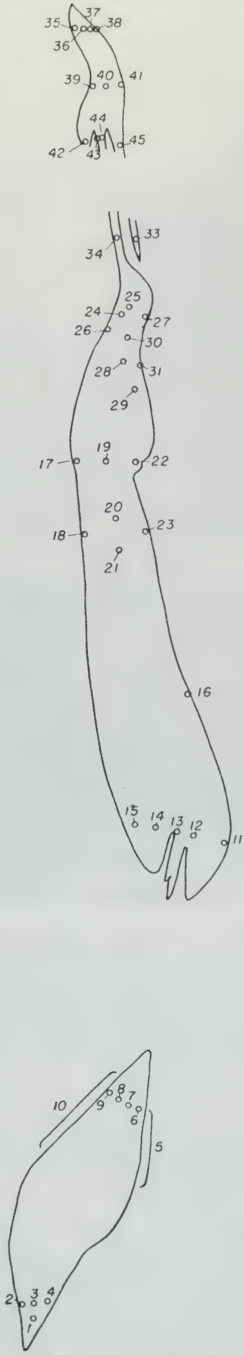

FIGURE 12. Map of Cool-Cave Valley limestone deposit showing locations where samples were taken.

FIGURE 13. Mountain Quarries, camera facing south. The quarry walls are nearly 600 feet high.

In 1946, the central portion of the northern lens south of Mountain Quarries, owned by the Henry Cowell Lime Company, 2 Market Street, San Francisco, was leased by the California Rock and Gravel Company, 1800 Hobart Building, San Francisco. For a time this property was worked for them under contract by E. B. Bishop. Production during this period was several hundred tons per day (Logan, 1947, p. 225). Since 1947, the California Rock and Gravel Company has operated the quarry.

Since 1948, the ''coyote hole'' method of quarrying has been employed. A quarry face 65 feet high and more than 300 feet long is being worked. Near the base of the quarry 40-foot adits or ''coyote holes'' 80 to 100 feet apart are driven perpendicular to the quarry face. At the ends of the adits 30-foot branches are driven perpendicularly or at large angles from the line of the adit so that they end about 20 feet from the end of the adjacent branch. The adits and branches

FIGURE 14. California Rock and Gravel Company quarry; camera facing north. Fall, 1952.

FIGURE 15. California Rock and Gravel Company quarry in Spring, 1953.

FIGURE 16. East face of California Rock and Gravel Company quarry near the main entrance. *Courtesy California Rock and Gravel Company.*

are then loaded with 40 percent Atlas dynamite. In 1952 approximately 18 tons of dynamite were used for this operation.

The entire dynamite charge is then shot electrically. About 150,000 tons are dislodged in the single blast, enough to sustain continuous plant operation for an entire year.[1] Secondary breaking of stone in the quarry is done with a 4-ton steel drop ball suspended from a crane. Power shovels then load the limestone into dump trucks which deliver it to the crushing plant about 1000 feet north of the quarry.

At the crushing plant the limestone is delivered to an electrically operated 30- by 42-inch primary jaw crusher, set at $7\frac{1}{2}$ inches. The rock then passes by belt conveyor to a trommel with 6-inch square holes. Oversize goes to a secondary crusher while undersize is delivered by inclined belt conveyor to a three-deck inclined trommel on top of three loading bins. Three sizes: plus 4- by minus 6-inches, plus 2- by minus 4-inches, and plus $\frac{1}{2}$- by minus 2-inches are classified into the bins. The minus $\frac{1}{2}$-inch rock is delivered by belt conveyor to a stockpile east of the crushing plant.

The coarsest and middle sized stone in the bins is trucked to Auburn where it is loaded into railroad cars and shipped to beet sugar refineries in the Sacramento and San Joaquin Valleys. The finest binned stone is trucked to the Hughes Vertin Lime Company plant at Rattlesnake Bridge where lime is manufactured in inclined rotary kilns. Occasionally, some of the plus $\frac{1}{2}$- by minus 2-inch limestone is shipped to steel

[1] Kelly, George, personal communication, 1952.

FIGURE 17. California Rock and Gravel Company plant. Quarry is out of view to right.

FIGURE 18. Sizing plant and loading bins at the California Rock and Gravel Company plant.

plants in the San Francisco Bay area where it is used as a flux in open-hearth steel furnaces. Nearly all of the undersize rock, not binned, is sold as road metal.

A five-day week is worked. Twenty-one men are employed at the quarry and crushing plant. Mr. George L. Kelly of Auburn is superintendent of the quarry and plant.

Estimated Reserves

It is estimated that the northern portion of the north lens, north of the Middle Fork of the American River, contains 1,125,000 tons of limestone per 100 feet of depth. The northern lens south of the river is estimated to contain 11,250,000 tons of limestone per 100 feet of depth. This estimate excludes that portion of limestone which has already been removed from Mountain Quarries. The southern lens is estimated to contain 5,850,000 tons of limestone per 100 feet of depth. Estimated tonnages are based on the limestone having an approximate weight of 150 pounds per cubic foot.

OTHER LIMESTONE DEPOSITS IN THE AREA

A number of other limestone deposits are in the general area of the Cool-Cave Valley deposit. The majority lie to the north and to the east in Placer County while a few are to the south in El Dorado County. Nearly all of the deposits have been worked at one time or another. Ruins of old stone lime kilns are at nearly every limestone deposit in the region.

Like the Cool-Cave Valley deposits, these deposits consist of almost completely recrystallized high-calcium limestone. On the basis of a small amount of fossil evidence, all are considered to be Carboniferous in age and to be part of the Calaveras group.

Approximately one mile west of the Cool-Cave Valley deposit on the south side of the Middle Fork of the American River, about 2000 feet southeast of the State Highway 49 bridge, is a small northwest-trending lens of dark bluish-gray limestone enclosed in metasediments. It is about 450 feet long and 50 feet wide. Three spot samples taken from this lens were analyzed and gave the following results. Number 1 was from the north end, #2 from the middle and #3 from the south end.

Sample	Insoluble	R_2O_3	P_2O_5	$MgCO_3$	$CaCO_3$
1	.96	.58	.08	.58	97.70
2	.42	.24	.06	.59	98.53
3	1.78	.30	.13	.58	97.21

A deposit known as the Auburn deposit just east of Auburn was quarried many years ago. It is composed of somewhat shattered white marble (Aubury, 1906, p. 101).

Just north of Auburn in sec. 3, T.12N., R.8E., M.D.M., is the Burton deposit which is composed of light gray, fine-to-medium-grained limestone. An analysis of a sample taken from this deposit by C. A. Logan gave the following result (1947, p. 263):

	Percent
Insoluble	1.06
Ferric and aluminum oxides	0.97
$CaCO_3$	96.3
$MgCO_3$	1.51

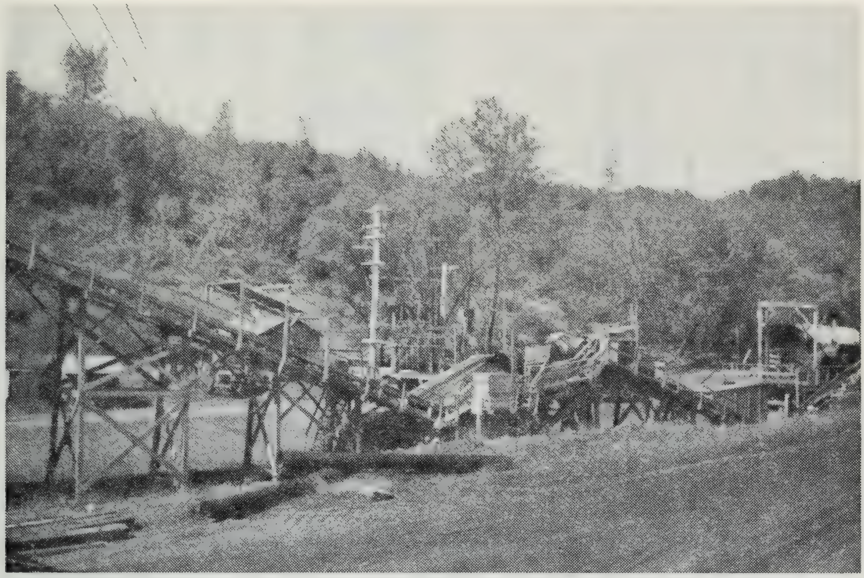

FIGURE 19. Crushing plant and trommel at the California Rock and Gravel Company plant.

The Cowell deposit 4 miles north of Auburn is partly covered by soil. The limestone is dark gray in color. A sample taken by C. A. Logan gave the following analysis (1947, p. 264):

	Percent
Insoluble	.60
Ferric and aluminum oxides	.99
$CaCO_3$	97.30
$MgCO_3$	1.09

Approximately 9 miles to the southwest is the Rattlesnake Bridge (Alabaster Cave) deposit. It is a north-striking high-calcium limestone deposit containing rock that is white to gray in color. It has an even, granular texture. An analysis of a sample taken from this deposit by C. A. Logan gave the following result (1947, p. 224):

	Percent
Insoluble	0.32
Ferric and aluminic oxides	0.27
$CaCO_3$	98.94
$MgCO_3$	0.38

Limestone has been produced from this deposit since the 1860's. Between 1930 and 1942 the deposit was worked by the Auburn Chemical Lime Company. In 1946, a rotary kiln and crushing equipment were installed. During that year the lime plant utilized limestone quarried at this deposit. Since 1947, however, all limestone has been purchased from the California Rock and Gravel Company at the Cool-Cave Valley deposit. Most of the lime produced is shipped to steel plants (Logan, 1947, p. 224).

North of the Cool-Cave Valley deposit in sec. 30, T.13N., R.9E., M.D.M., about 1 mile south of Clipper Gap station are two smaller deposits, Lime Rock and the DeWitt deposit.

Table 1. Limestone deposits in the general area of the Cool-Cave Valley limestone.

Number on map (plate 3)	Deposit	Owner	Location				References
			Sec.	T.	R.	B & M	
1	Auburn	Wendell T. Robie, Auburn	14	12N	8E	MD	Aubury 06:101; Logan 27:281; herein.
2	Brown's Bar	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco.	33 4	13N 12N	9E 9E	MD MD	Herein.
3	Buckeye Canyon	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco.	34	13N	9E	MD	Herein.
4	Burton (Petterson)	O. J. Burton, Route 3, Box 3350, Auburn	3	12N	8E	MD	Logan 27:282; 47:263; herein.
5	Cool-Cave Valley	North ¼ owned by Pacific Portland Cement Company, 417 Montgomery Street, San Francisco. South ¾ owned by Henry Cowell Lime and Cement Company, 2 Market Street, San Francisco.	6,7 18	12N	9E	MD	Hanks 84:107; Crawford 94:391-392; Lindgren 94:3; Crawford 96:628; Aubury 02:17; 06:68; Tucker 19:304, 390-391; Logan 21:431-432; 24:8; Young 25:13-16; Logan 26:442, 443; 27:282; Laizure 27:208; 29:251; Logan 38:277, 280; 47:222, 224-226, 232-233; Bowen and Crippen 48:73, 80; herein.
6	Cowell	Henry Cowell Lime and Cement Company, 2 Market Street, San Francisco.	22	13N	8E	MD	Logan 27:281; Logan 47:263-264; herein.
7	DeWitt	Eleanor DeWitt, 1931 C Street, Sacramento.	30	13	9E	MD	Tucker 19:391; Logan 27:282; 47:264; herein.
8	Hotaling	Dorothy R. Wold and Chas. Pennington, 32 Overhill Road, Orinda.	15	13N	8E	MD	Hanks, 84:110; Logan 27:281; 47:264; Bowen and Crippen 48:73; herein.
9	Lime Rock	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco.	30	13N	9E	MD	Tucker 19:391; Logan 47:265; herein.

10	Limestone depost one mile west of Cool-Cave Valley deposit near State Highway 49 bridge.	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco	12	12N	8E	MD	Herein.
11	Long Point	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco.	21	13N	9E	MD	Logan 48:266; herein.
12	Muegge	T. C. Muegge, 450 Sutter Street, San Francisco.	29	13N	9E	MD	Logan 47:265; herein.
13	Pacific Portland Cement	Pacific Portland Cement Company, 417 Montgomery Street, San Francisco.	21, 28	13N	9E	MD	Aubury 06:74; Logan 27:281; 47:265-266; herein.
14	Rattlesnake Bridge (Alabaster Cave)	C. L. Vertin, P.O. Box 718, Salinas	15	11N	8E	MD	Aubury 06:65-68; Tucker 19:304; Logan 21:432; 24:8; 26:442-443; 38:273-274; 47:222, 223-224; herein.
15	Spreckels	C. F. Brunkhorst, Applegate	8,9	13N	9E	MD	Tucker 19:391; Logan 27:282; 47:266; herein.

Lime Rock, a well-known landmark in the area, stands out prominently from the surrounding metavolcanics and metasediments. On the north end, the deposit rises 70 feet above the land surface, while at the south end the face extends at least 500 feet down the slope toward the North Fork Dam. The deposit is about 150 feet wide and 300 feet long. Six samples taken from this deposit were analyzed by Abbot A. Hanks, Inc. Samples 1, 2, 3 and 4 were taken at 400-foot intervals across the strike while #5 is a composite sample of chips taken along the eastern edge of the deposit and #6 was taken along the western edge.

Sample	Insoluble	R_2O_3	P_2O_3	$MgCO_3$	$CaCO_3$
1	.28	.36	.07	.25	99.04
2	.72	.42	.16	.43	98.27
3	.82	.46	.18	.59	97.95
4	.34	.48	.17	.51	98.50
5	.72	.50	.15	.54	98.09
6	.60	.74	.11	.65	97.90

The DeWitt deposit is about half a mile northwest of Lime Rock just north of Clipper Creek. It is 250 feet long and varies from 50 to 100 feet in width. Six samples taken from this deposit were analyzed by Abbot A. Hanks, Inc. Samples 1, 2, 3 and 4 were taken at 25-foot intervals across the center of the lens, while #5 is a composite sample of chips taken along the eastern edge and #6 was taken along the western edge.

Sample	Insoluble	R_2O_3	P_2O_3	$MgCO_3$	$CaCO_3$
1	16.96	1.74	.10	3.66	77.54
2	.96	.42	.09	1.13	97.40
3	1.34	.46	.06	.83	97.31
4	2.42	.54	.06	.77	96.26
5	1.76	.76	.05	1.20	96.23
6	3.70	.66	.05	4.32	91.27

Southeast of Lime Rock on the south side of North Fork reservoir is the Muegge deposit which is partly covered by water. Although it is 225 feet wide at the water's edge, it extends for only a short distance up the slope.

At Hotaling, 3½ miles west of Clipper Gap is a small deposit of coarse, white, granular limestone. This was used at the iron smelter operated at Hotaling in the 1880's (Logan, 1947, p. 264). A sample, taken from this deposit and analyzed by Abbot A. Hanks, gave the following result:

Insoluble	R_2O_3	P_2O_5	$MgCO_3$	$CaCO_3$
.22	2.72	.12	.79	96.15

The Spreckels deposit half a mile southeast of Applegate was worked by the Spreckels Sugar Company for one year ending in October 1916. It is fine-grained bluish-gray limestone. The deposit is 650 feet long and varies from 100 to 200 feet in width (Logan, 1927, p. 282).

Lying to the east on both the Middle and North Forks of the American River are several other limestone deposits. The largest of these, which is listed in the tabulated list as the Pacific Portland Cement deposit, is cut by the North Fork of the American River and is 2½ miles south of Applegate. It is nearly a mile long and several hundred feet wide. The limestone is medium-grained and light-blue-

gray in color. Veins and veinlets of chert are present here and there in this deposit.

Just east of this on Long Point is a small deposit of cherty limestone.

Two other deposits are at Brown's Bar and Buckeye Canyon on the south side of the Middle Fork of the American River about 3 miles east of the Cool-Cave Valley Deposit. Both deposits, owned by the Pacific Portland Cement Company, 417 Montgomery Street, San Francisco, apparently have never been worked because of their inaccessability.

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MINES AND MINERAL DEPOSITS OF LOS ANGELES COUNTY, CALIFORNIA*

By Thomas E. Gay, Jr.** and Samuel R. Hoffman **

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ABSTRACT

Los Angeles County covers 4,071 square miles in southwestern California, including rugged mountains, fertile valleys, coastal plain, desert area, and Pacific islands. Except for the desert area in the north the county lies within the Peninsular Ranges and Transverse Ranges geomorphic provinces, characterized by northwest- and west-trending mountain ranges respectively.

Sedimentary, metamorphic, and igneous rocks are extensively exposed. Sedimentary rocks, ranging from Cretaceous through Tertiary in age, are distributed widely in the southern and western parts of the county. The principal sites of deposition were the Los Angeles and Ventura basins, with geologic histories that differed at times, but each receiving a total thickness of more than 40,000 feet of sediments.

Metamorphic rocks include pre-Cambrian (?) Pelona schist; Triassic (?) Santa Monica slate, phyllite, and schist; and the pre-Cretaceous Catalina series and metamorphic rocks of the San Gabriel Mountains. Various intrusive and extrusive types of igneous rocks, Jurassic (?) and later in age, are exposed in the mountain areas.

As a result of its tremendous production of oil and gas, the 1951 mineral production of Los Angeles County was the largest in value of any county in the state. The county's mineral production for that year was valued at $282,948,130. Of this total, petroleum and natural gas accounted for $264,654,011. Cement, clay, diatomite, gold, granite, iodine, sand, gravel, silver, soapstone, stone, and titanium concentrates accounted for the rest.

The county also leads the state in total value of mineral production. Approximately 90 percent of the recorded $4,524,761,130 in mineral wealth extracted in the county through 1951 has been derived from petroleum and natural gas. The remaining 10 percent includes 28 mineral substances: asphalt, barite, borax, clay, copper, dolomite, diatomite, feldspar, gem stones, gold, graphite, gypsum, iodine, lead, limestone, magnesium chloride, manganese, marble, mineral water, miscellaneous stone, potash, salt, silica, silver, sulphur, talc, titanium, and zinc.

Nonmetallic minerals, led by sand, gravel, and crushed rock, common clay, and diatomite, account for the bulk of the county's production. Most of the sand, gravel, and crushed rock operations are in the Big Tujunga Wash in San Fernando Valley, and in the San Gabriel and Rio Hondo Washes in San Gabriel Valley. Common clay from numerous sites near industrial Los Angeles is used to make brick, tile, and sewer pipe. Diatomite is produced from a large deposit on the north side of the Palos Verdes Hills. Brines from certain oil wells in several oil fields are the source of all the crude iodine produced in the United States.

Gold, with a total recorded production of more than $2,258,000 through 1950, leads the metallic minerals in value. Most of this output has been obtained from the quartz veins of the Governor mine near Acton. Lead, silver, and zinc were produced from 1919 to 1929 from deposits on Santa Catalina Island. Large reserves of titaniferous magnetite occur in the western San Gabriel Mountains. Several concentrations of titaniferous magnetite sands in stream beds and beach deposits have been mined.

The Los Angeles basin is the most productive oil-producing region of its size in the world. Wells in the county have yielded more than 3 billion barrels of oil and $3\frac{1}{2}$ million cubic feet of gas through 1952, obtained from 37 separate fields in the Los Angeles and Ventura basins. Oil has accumulated in sandstones of lower Pliocene and upper Miocene age and in fractured pre-Cretaceous metamorphic rocks.

INTRODUCTION *

Exploration of the Los Angeles region began as early as 1542, when Juan Cabrillo discovered Santa Catalina Island and what is now San Pedro Bay. The site of the present city of Los Angeles was not seen by white men until 1769 when the Portola expedition, traveling north to find the bay of Monterey, encamped near the Indian village of Yang-na in an area now occupied by Elysian Park.

The pueblo of Los Angeles, one of the first settlements to be established in California, was founded in 1781 under the authority of Carlos III, King of Spain. Until the Mexican War and the American occupation, Los Angeles grew slowly but consistently in population. In 1850, when Los Angeles County had a population of 8,329 and the city of Los Angeles had a population of 1,610, the city was incorporated and made the county seat.

Los Angeles County was organized in 1850 as one of the 27 original counties of California. In 1851 its boundaries were extended to include most of southern California between Santa Barbara and San Diego, an area of some 31,000 square miles, reaching eastward to the state line.

* California Blue Book, 1950; Hastings House, 1941.

FIGURE 1. Physiographic sketch of Los Angeles County.

In 1853 the present eastern boundary was established through the formation of San Bernardino County. In 1866 the present northern boundary was defined with the creation of Kern County, and in 1889 the southern boundary was revised to its present position, with the establishment of Orange County. Los Angeles County now contains 4,071 square miles and measures about 75 miles from north to south and 70 miles from east to west.

During the late 1800s Los Angeles grew slowly, but in the twentieth century the city and the surrounding area experienced a phenomenal population and industrial growth. The Los Angeles area is now one of the great port cities of the world, one of the great railroad centers of the country, and the third largest manufacturing city in the United States. Sharing in this growth are the smaller cities and towns in Los Angeles County.

The population of Los Angeles County was 4,125,000 in April 1950, an increase of 48 percent over 1940. About 79 percent of the residents of the county live inside incorporated cities and the remainder live in unincorporated towns or rural areas.

Geography

Los Angeles County is in the southwestern part of California and is bounded by Kern County on the north, San Bernardino and Orange Counties on the east, Ventura County on the west, and the Pacific Ocean on the west and south.

Four main physiographic features stand out in Los Angeles County: (1) the coastal plain, known also as the Los Angeles basin, which borders the ocean on the north and east; (2) the structurally similar San Fernando and San Gabriel Valleys, separated from the coastal plain and from each other by low hills; (3) the massive San Gabriel Mountains, north of the San Gabriel Valley and San Fernando Valley; and (4) the Mojave Desert in the northernmost part of the county, its western part known as Antelope Valley.

The coastal plain meets the Pacific Ocean along nearly 75 miles of coastline, roughly divided into two crescent-shaped bays, Santa Monica Bay, facing west, and San Pedro Bay, facing south. On the southwestern tip of the mainland are the Palos Verdes (San Pedro) Hills, a peninsula about 5 by 10 miles in extent, with a maximum altitude of 1,480 feet, and bordered by sea cliffs. Terraces exist at elevations as high as 1,300 feet in these hills. Terraces as much as 200 feet above the ocean occur in the northwestern part of the coastal plain near Santa Monica. The coast also contains many sandy beaches. A 3-mile long, beach-barred lagoon south of Wilmington, with an artificial entrance cut through its beach, serves as the harbor for the maritime commerce of Los Angeles.

About 25 and 55 miles south of the harbor, respectively, are the islands of Santa Catalina and San Clemente. These have rugged coast lines and mountainous interiors reaching 2,125 feet in altitude on Santa Catalina Island.

On the northwest, the gently sloping coastal plain is separated from the San Fernando Valley by the west-trending Santa Monica Mountains. To the north and northeast a group of low hills, including the Repetto Hills, San Jose Hills, and Puente Hills, separates the coastal plain from the San Gabriel Valley.

The San Fernando and San Gabriel Valleys would be a continuous topographic feature were they not separated by the Verdugo Mountains and San Rafael Hills, both foothills of the San Gabriel Mountains. The Santa Susana Mountains and Simi Hills, lying athwart the west boundary of the county south of the Santa Clara River, border the San Fernando Valley on the west.

Streams flow from the San Gabriel and Santa Monica Mountains into the two valleys and the coastal plain. The Los Angeles River, flowing from San Fernando Valley, and the San Gabriel River, flowing from San Gabriel Valley, are the principal drainage courses, and these streams are usually dry during summer months. Other streams sink beneath the porous valley alluvium and disappear within a few miles of the mountain base.

The west-trending San Gabriel Mountains rising north of the valleys form the dominant mountain range in Los Angeles County, being about 20 miles wide and about 45 miles long within the county. The range is rugged and steep. Mount Baldy (San Antonio Peak), at the

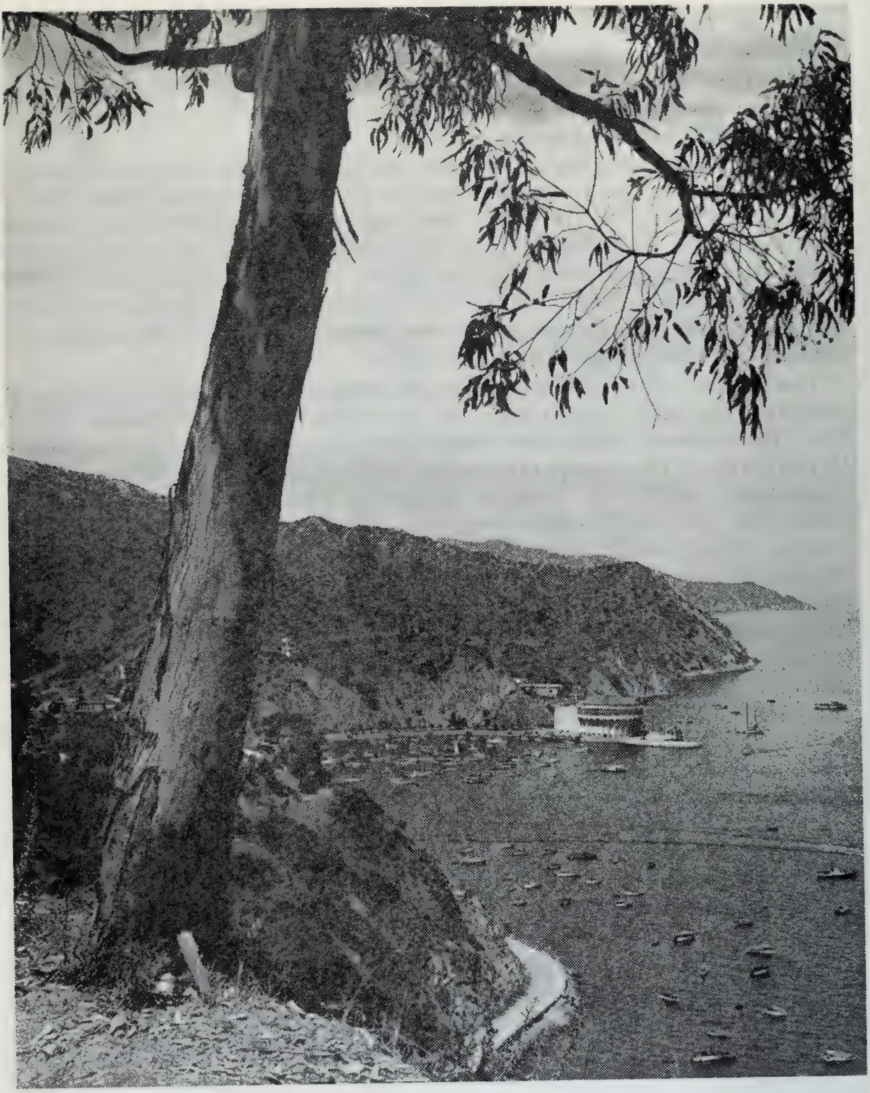

FIGURE 2. View north toward Avalon Bay on Santa Catalina Island. *Photo courtesy All Year Club of Southern California.*

east boundary of the county, reaches an altitude of 10,080 feet, and several peaks exceed 8,000 feet in elevation. The higher peaks, toward the eastern end of the county, are commonly snow-covered in winter.

On the north side of the San Gabriel Mountains the Santa Clara River traverses the eastern part of the Ventura Basin, following a valley trending slightly south of west from Antelope Valley to the ocean. Extending northwest across the Santa Clara River to the northwestern corner of the county are mountainous regions known as the Sierra Pelona and Ridge Basin. Antelope Valley and the Mojave Desert form a desert basin in the northernmost part of the county, roughly

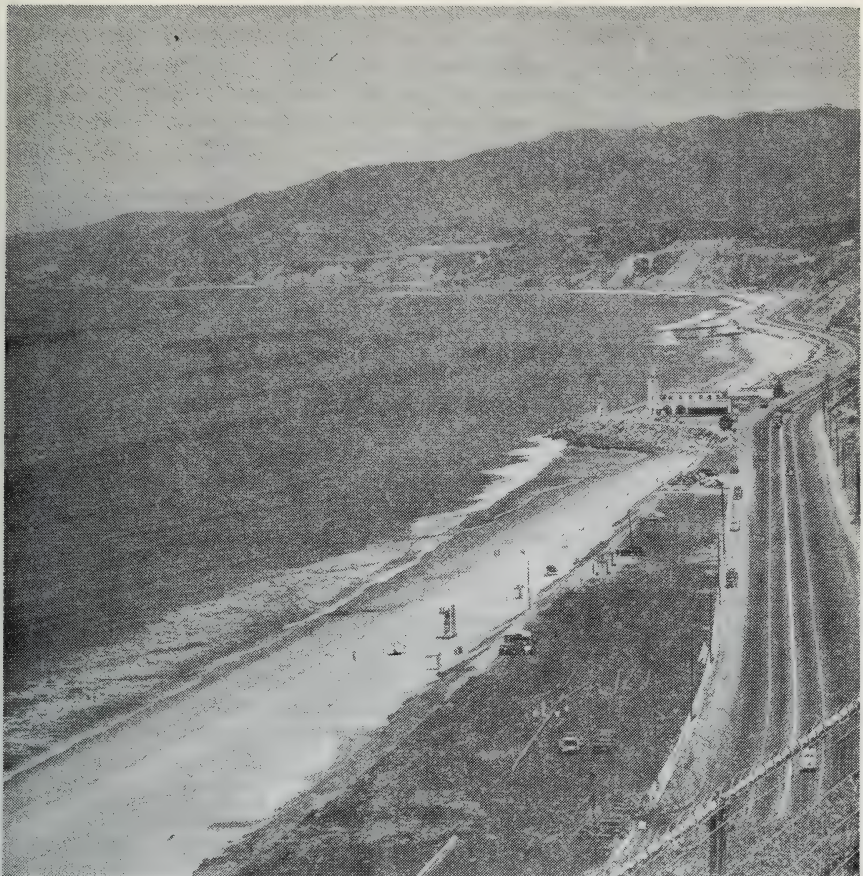

FIGURE 3. Terraces and cliffs at Santa Monica. *Photo courtesy All Year Club of Southern California.*

separated from the highland areas to the south by the San Andreas fault zone. Several sag ponds have formed along the San Andreas fault zone. The largest of these, Elizabeth Lake, is about 2 miles long.

The diversity of topographic expression in Los Angeles County results in a variety of climatic conditions. Temperature and cloudiness vary generally with distance from the coast, the areas near the coast being cooler and more cloudy. Precipitation ranges from an average of about 4.5 inches per year in the desert area to as much as 38 inches per year in some parts of the San Gabriel Mountains (U. S. Dept. Commerce, 1946).

The three main types of native vegetation in Los Angeles County are the hard-leaved shrubs and dwarf trees on the foothills, coniferous forests on the mountain ranges, and plant life in Antelope Valley and the Mojave Desert. The most characteristic of these types is the so-called chaparral, a tangle of shrubs and dwarf trees, composed of chamise, mountain mahogany, toyon, manzanita, and others. Chaparral grows from sea level to an elevation of about 4,000 feet.

Summary of economic geology of Los Angeles County.

Geologic age			Rock units	Mineral deposits
CENOZOIC	Quaternary	Recent	Alluvial sand, gravel	Sand, gravel, crushed rock (aggregate)
			Alluvial clay, silt, sand	Common clay
			Dune sand	Sand for specialty uses
		Pleistocene	Continental conglomerates, sands, silts, clays	Decomposed granite
			Marine sands, gravels, clays, marl	Sands for specialty uses Marl (agricultural stone)
	Tertiary	Pliocene	Marine siltstone, sandy shale, sandstone; minor gypsiferous shales	Major source of oil Gypsite
		Miocene	Marine sandstone, clay, shale, siliceous shale, diatomaceous shale, conglomerate; volcanic members	Major source of oil Diatomite
		Oligocene (?)	Largely nonmarine conglomerate, conglomeratic sandstone, siltstone, gypsiferous and borate-bearing layers; volcanic rocks	Gypsite Borates
		Eocene and Paleocene	Marine conglomerate, sandstone, shale, limestone lenses	Minor source of oil Limestone (dimension stone and riprap)
MESOZOIC	Cretaceous	Upper cretaceous	Marine massive sandstone, conglomerate, minor shale	Sandstone (dimension stone)
	Jurassic (?)		Catalina metamorphic series: glaucophane schists, amphibolite schists, metasediments	Lead-silver-zinc sulphide vein deposits (Santa Catalina Island) Minor source of oil (fractured schist)
			Granitic intrusive rocks: granite, granodiorite, quartz diorite, etc.	Riprap, fill rock (granitic and metamorphic rocks) Gold-bearing quartz veins
	Triassic (?)		Metamorphosed marine shale: slate, phyllite, mica schist	
PALEOZOIC (?)			Metamorphosed marine sediments: limestone, dolomite, graphite schist, sillimanite schist, gneiss, hornfels, etc. Dioritic instrusive rocks	Limestone (poultry grit) Graphite Gold-bearing quartz veins
PRE-CAMBRIAN (?)			Metamorphosed marine sandstones, tuffs: mica schist, talc schist, graphite schist, limestone, quartzite, etc. Granitic intrusive rocks: quartz diorite, diorite, aplite, etc. Basic intrusive rocks: gabbro, anorthosite, norite, etc., titaniferous magnetite bodies	Flagstone "Soapstone" Graphite Minor potash feldspar and silica from veins Gold-bearing quartz veins Anorthosite (chicken grits and abrasive for cleanser) Titaniferous magnetite

Of the 2,650,440 acres in the county, 645,045 acres are included in the Angeles and Los Padres national forests. About 11 percent of the county consists of military reservations and county, municipal, and state parks. Cultivated or urban and industrial areas comprise some 702,000 acres, of which 320,000 acres are agricultural crop land.

The industrial development of Los Angeles County in recent years has made this area the third largest manufacturing center in the

United States (Arthur, 1947). Los Angeles leads major American industrial centers in diversification of industry with nine predominant industries: aircraft production, motion pictures, automobile assembly, petroleum refining, rubber tires and rubber goods, furniture manufacturing, oil well equipment and tools, food products, and sportswear manufacturing. Los Angeles County leads the nation in five industries, is second in ten industries, third in eleven, and fourth in sixteen industries.

The county has a well-developed system of roads, including, in addition to city streets, 955 miles of state highway, 4,128 miles of maintained county roads, and 2,014 miles of primary county roads. Major highways include U. S. Highway 101, which follows the coast; Highways 60 and 66, paralleling each other in an easterly direction; Highway 395, traversing the eastern part of the county in a north-south direction; and Highways 99 and 6, entering from the north.

Three transcontinental railroads, the Santa Fe, Southern Pacific, and Union Pacific, serve the county as do major inter- and intra-state bus and truck lines. Large tonnages of material are exported and imported at the Los Angeles-Long Beach harbor. Airports of major importance are located near Burbank in San Fernando Valley and at Inglewood near the coast.

Topographic maps published from 1930 to 1950 cover the entire county on the scale of 1:24,000 in quadrangles of six minutes of latitude and longitude (U. S. Geol. Survey, 1952). A series of 7½ minute quadrangle maps, which will also cover the county, is being published. Smaller-scale topographic maps, 15 or 30 minutes on each side, have also been published for some parts of the county (Atherton, 1952).

Geology

Rock Units and Associated Mineral Deposits

Pre-Cambrian (?) Rocks. Little is known of the geologic history of Los Angeles County during the earliest part of geologic time, the pre-Cambrian era. The Pelona schist, a series of metamorphic rocks exposed along the south margin of the Mojave Desert, is generally believed to be pre-Cambrian in age. The Pelona schist series is composed of a large variety of metamorphic rocks, including mica schist, actinolite schist, talc schist, sillimanite schist, hornblende schist, graphite schist, crystalline limestone, quartzite, and metamorphosed volcanic rocks. The rocks originally were arkosic sandstones, lavas, and tuffs (Simpson, 1934, p. 378-381).

The largest exposure of Pelona schist is in the Sierra Pelona, but less extensive exposures are present along the San Andreas fault zone north of Sierra Pelona and also near the east border of the county. In the Sierra Pelona, the schist is flanked to the north and south by granitic intrusive rocks. South of the Sierra Pelona the intrusive rocks are predominantly quartz diorite, but include granitic, dioritic, syenitic, and aplitic types (Simpson, 1934, p. 384). These intrusive rocks have been estimated to be as old as pre-Cambrian (Miller, 1931, p. 333; Hershey, 1902, p. 279), but they may be correlatives of the upper Jurassic (?) Sierra Nevada rocks (Simpson, 1934, p. 384). South of the easternmost Ventura basin (Soledad basin) in the western San Gabriel Mountains are exposed plutonic rocks of more basic composition, including

anorthosite, gabbro, norite, and related rocks. Anorthosite, a coarsely crystalline rock consisting of more than 90 percent plagioclase feldspar, crops out over an area of more than 60 square miles in this region. Estimates of the age of these rocks, as of the granitic rocks south of the Sierra Pelona, have ranged from pre-Cambrian to late Mesozoic; conclusions from recent work favor a pre-Cambrian age. The granitic rocks on the north flank of the Sierra Pelona are thought to be younger, probably late Mesozoic in age (Simpson, 1934, p. 384).

The Pelona schist and associated igneous rocks have yielded significant amounts of mineral materials. The Pelona schist has been quarried for flagstone. Graphite schist and talc schist of this series have yielded graphite and soapstone, respectively. Unmined bodies of limestone occur in the Pelona schist series near the eastern edge of the county. A small amount of potash feldspar was obtained from a pegmatite dike; several quartz veins have yielded silica. The gold mines of the Acton area, including the highly productive Governor (New York) mine, are on quartz veins in the dioritic intrusive rocks south of the Sierra Pelona. Titaniferous magnetite bodies are associated with the anorthosite bodies and have been prospected in many places. The principal production of titaniferous magnetite has been from the Iron Blossom mine near Lang, and from placer concentrations in streams and beaches. Small amounts of anorthosite have been mined in the past, principally for use as abrasive in cleanser and for chicken grits.

Paleozoic (?) Rocks. The record of the next geologic era, the Paleozoic, also is obscure, but suggests the presence of early seas in the county. The Placerita series, composed of metamorphosed sedimentary rocks, has been tentatively assigned a Paleozoic-Carboniferous age by Oakeshott (1937, p. 219), but Miller (1934, pp. 64-65) has suggested a pre-Cambrian age. Exposures of the Placerita series are confined to limited areas in the western San Gabriel Mountains, and consist of crystalline limestone and dolomite, graphite schist, biotite schist, sillimanite schist, quartzite, and gneiss. These rocks are intruded in places by a gneissic diorite and hornblendite called the Rubio diorite. The Rubio rocks are assigned a late Paleozoic age by Oakeshott (1937, p. 223, 224). Miller (1934, p. 50, geologic map) includes Placerita metasediments and Rubio metadiorite in the pre-Cretaceous San Gabriel formation which is widely exposed in the San Gabriel Mountains.

Small exposures of metamorphosed limestone that appear enclosed in quartz monzonite in the southwest flank of Antelope Valley may also be of Paleozoic age (Wiese, 1950, p. 18; Smith, 1951). These rocks are composed mostly of white or gray limestone with minor amounts of pink or green calc-silicate hornfels, quartzite, and gray quartz-biotite hornfels (Wiese, 1950, p. 18).

Gold-bearing quartz veins exist in the Neenach area, near the contact between intrusive quartz monzonite and Paleozoic (?) metasedimentary rocks (Wiese, 1950, p. 47). In the Placerita metasedimentary series small amounts of dolomitic limestone and graphite schist have been mined, principally for poultry grit and graphite, respectively.

Mesozoic Rocks. Rocks of the Mesozoic era, which is subdivided into the Triassic, Jurassic, and Cretaceous periods, are more extensively exposed than are the older rocks. The Santa Monica slate is probably

the oldest of the Mesozoic rock units in Los Angeles County. It has not yielded fossils, but is generally assigned a Triassic age on the basis of its resemblance to fossiliferous Triassic slate in the Santa Ana Mountains of Orange County (Hoots, 1931, p. 88). The Santa Monica slate, extensively exposed in the Santa Monica Mountains, is a metamorphosed marine shale, several thousand feet thick. It is dark gray and contains thin beds of light-gray siltstone and fine- to coarse-grained sandstone. Much of the slate has been further metamorphosed to mica schist and dark-gray phyllite. The slate is too fissile and too abundantly jointed to be used as building material.

Middle Mesozoic time was marked by the extensive intrusion of large masses of granitic rocks and by the metamorphism of the invaded sedimentary rocks. This activity is believed to have been most pronounced in Upper Jurassic and Lower Cretaceous time. The intrusive rocks are principally granite, granodiorite, quartz diorite and quartz monzonite. They are most extensively exposed in the Liebre Mountain area, Antelope Valley area, San Gabriel Mountains, south of Ridge Basin, and Santa Monica Mountains. On Santa Catalina Island quartz diorite intrudes Jurassic (?) metamorphic rocks and possibly should be included with this group.

Jurassic (?) metamorphic rocks known as the Catalina series (Woodford, 1924, p. 49-68) are exposed on Santa Catalina Island and in the Palos Verdes Hills. This series contains a variety of schists, including glaucophane schist, a rock characteristic of the Franciscan group which is Jurassic in age and occurs in the Coast Ranges of California (Woodring, 1946, p. 12). The lead-silver-zinc deposits of Santa Catalina Island are sulphide-bearing veins in rocks of the Catalina series. At scattered locations throughout the country quartz veins in Jurassic (?) granitic intrusive rocks have yielded small amounts of gold. Jurassic (?) granitic rock has been of little use as construction material because it is generally intensely shattered and weathered. However, a large tonnage of Jurassic (?) granitic and metamorphic rock has been quarried in the San Gabriel Mountains, Palos Verdes Hills, and Santa Catalina Island for use in dam and harbor projects. A small amount of oil has been recovered from fractured Jurassic (?) schist and from an overlying schist conglomerate in the western Los Angeles basin area. (See oil and gas section of this report.)

The Upper Cretaceous and later geologic history of Los Angeles County, as recorded in thick and extensive sections of sedimentary rocks, is much better understood than is the county's earlier geologic history. Although sedimentation has been interrupted, from time to time, by deformation and erosion, the stratigraphic record is relatively complete. In the Santa Monica Mountains and on the west margin of the San Fernando Valley, more than 5,500 feet of Upper Cretaceous sedimentary rocks are exposed (Kew, 1924, pp. 11-12). The rocks are principally massive brown and gray conglomerate and sandstone with subordinate dark gray shale (Hoots, 1931, p. 90). Cretaceous sandstone has been quarried in large tonnages near Chatsworth for use in the construction of buildings, breakwaters, and retaining walls.

Cenozoic Rocks. The Cenozoic era is abundantly represented by Tertiary and Quaternary sedimentary formations that now cover a large

FIGURE 4. Aerial view northwest toward central manufacturing district of Los Angeles. Los Angeles River in foreground, Santa Monica Mountains at left rear, San

Gabriel Mountains at far rear. *Pacific Air Industries photo courtesy Los Angeles Chamber of Commerce.*

part of the county. Great thicknesses of Tertiary marine sandstones and shales, principally Miocene and Pliocene, are found in the Los Angeles and eastern Ventura basins. Nonmarine Tertiary sedimentary rocks are also extensively exposed. Quaternary alluvium and nonmarine sediments now cover most of the flat-lying areas of the county such as the coastal plain, San Fernando, San Gabriel, and Antelope Valleys.

Sedimentary rocks were deposited in Los Angeles County in each of the major subdivisions of the Cenozoic era (Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs of the Tertiary period and Pleistocene and Recent epochs of the Quaternary period). Marine sediments were deposited in all of the epochs, with the possible exception of the Oligocene. Nonmarine units, exposed mainly in the northeastern part of the county, range in age from upper Eocene to Recent. Intermittent volcanism in the Tertiary period contributed large volumes of intrusive and extrusive basaltic rocks, particularly during the Miocene epoch when large areas in the western Santa Monica Mountains, Antelope Valley, Santa Catalina and San Clemente Islands, and the San Jose Hills area were covered by lava flows. In the easternmost Ventura basin large volumes of volcanic rocks were deposited in Oligocene (?) time; some also in Miocene time.

Cenozoic sedimentary rocks underlie more than half of the county, particularly the lower areas. The most complete sections of Tertiary sediments are found in the Los Angeles basin, in the coastal plain area,* and in the eastern part of the Ventura basin, lying northwest of the San Gabriel Mountains. Most Tertiary rocks exposed in the county are Miocene or Pliocene in age.

Paleocene and Eocene sedimentary rocks are not exposed in the coastal plain area and only occur locally on the south flank of the Santa Monica Mountains, in the margins of the eastern Ventura basin, and in isolated slivers along the San Gabriel and San Andreas fault zones. Several thousand feet of Eocene and Paleocene marine conglomerate, sandstone, and shale beds of the Martinez and Meganos formations crop out northwest of San Fernando Valley, but only minor exposures extend into Los Angeles County (Kew, 1924, plate 1). The most extensive exposure of Paleocene rocks in the county is in the upper Castaic Creek area, south of the Liebre Mountain area, where pebble and cobble conglomerates of probable Paleocene age are exposed (Clements, 1927, p. 214; Smith, 1951, geologic map).

A minor amount of oil has been produced from Eocene strata in the Aliso Canyon and Newhall oil fields. In Santa Ynez Canyon, on the

* In this report the term coastal plain refers to the present topographic lowland extending inland from the Pacific Ocean and bounded by the Santa Monica Mountains, Repetto Hills, and Puente Hills. This area is popularly known as the Los Angeles basin. In a geological sense, the term Los Angeles basin is generally applied to the basin of marine deposition which existed for much of Tertiary time and extended as far inland as Pomona and Pasadena, southward into Orange County, and as far northward as the eastern Ventura basin, covering what now is the Santa Monica Mountains and San Fernando Valley. The term Ventura basin is applied to another Tertiary basin of marine deposition, lying mainly in Ventura County. Only its eastern extremity lies within Los Angeles County, where it is now generally a topographic low area but partly hilly and with moderate relief. This area, in which appear uplifted Tertiary basin sediments, is referred to in this report as the eastern Ventura basin area; and easternmost Ventura basin in the Mint Canyon-Soledad Canyon area. A third basin noted in this report is the Ridge Basin, in the northwestern corner of the county. A topographic basin of deposition during much of Tertiary time, the Ridge Basin area is now a mountainous region of pronounced relief. As in the cases of the Los Angeles and Ventura basins, the term Ridge Basin is retained for the area in which the Tertiary basin sediments accumulated and are now exposed.

south flank of the Santa Monica Mountains, deposits of Paleocene limestone have long been sources of building stone and riprap.

Oligocene (?) rocks of the Sespe formation, which is probably largely or wholly nonmarine, crop out in the western Santa Monica Mountains and consist of a thickness of one thousand feet or more of light gray and red conglomerate and conglomeratic sandstone (Hoots, 1931, pp. 93-94). At the easternmost end of the Ventura basin a 9,000-foot section of nonmarine siltstone, sandstone, and conglomerate, with subordinate breccia, limestone, tuff, and gypsiferous and borate-bearing layers, is known as the Vasquez series, tentatively assigned an Oligocene age (Jahns, 1940, p. 170; 1951, p. 1504). A 4,000-foot thickness of intertongued basaltic flows and breccias brings the total thickness of the Vasquez series to 13,000 feet.

The borate-bearing strata in the Vasquez series were the source of important tonnages of borates formerly produced at the Lang mine in Tick Canyon. Gypsum, in the form of gypsite, has also been produced from gypsiferous layers in rocks of the Vasquez series in Mint Canyon. No oil is known to have been produced from Oligocene sediments in the county.

In the southern part of the county Miocene sedimentary rocks are as much as 14,500 feet thick and are predominantly marine. As noted above, they locally contain abundant intrusive and extrusive bodies of basalt. In the easternmost Ventura basin area nonmarine Miocene strata are abundant. A series of uplifts and downwarps, accompanied by folding and faulting, caused the centers of deposition and erosion to shift during Miocene time. Consequently individual formations show marked differences in thickness and lithology from place to place, and widespread unconformities exist. The principal Miocene formations in Los Angeles County are the Vaqueros and Tick Canyon (lower Miocene), the Topanga (middle Miocene), and the Monterey, Modelo, or Puente, and Mint Canyon (upper Miocene). The dominantly marine Topanga formation is more widely exposed than the lower Miocene formations in the county and consists of as much as 7,500 feet of sandstones, clay shales, and conglomerates; it contains abundant intrusive and extrusive basaltic rocks (Eckis, 1934, p. 38).

The most widespread Miocene formation and the one of greatest economic importance is a shaly unit known as the Modelo, in the western part of the county, as the Puente in the eastern part, and as the Monterey formation in the Palos Verdes Hills. The formation has an exposed thickness of nearly 9,000 feet south of the Santa Clara River, where it consists largely of diatomaceous or siliceous shale that locally contains coarse sandstone lenses, conglomerate beds, and intrusive and extrusive basaltic bodies (Kew, 1924, p. 56). This formation includes the principal oil-producing zones in eastern Ventura basin, and is an important source of oil in fields of the Los Angeles basin. The source of the diatomaceous earth produced in the Palos Verdes Hills is the Valmonte diatomite member of the Monterey shale, corresponding in age to the Modelo (Puente) formation (Woodring, 1946, pp. 13, 15).

Pliocene sediments are abundantly present in Los Angeles County, and like the Miocene, show conspicuous lateral gradations in character and thickness. In the Los Angeles basin as much as 7,000 feet of marine Pliocene rocks occur in drill cores and consist essentially of siltstone,

sandy shale, and sandstone, with conglomerate members. Deformation of the Pliocene strata, like the Miocene, has been severe in many areas, and most oil fields are located over folded and faulted zones where oil has been trapped. Pliocene marine sediments are ordinarily divided into two general units, the Repetto and Pico formations, representing the lower and upper parts of the epoch, respectively. In the Ridge Basin area in the northwest corner of the county is exposed a 22,000-foot section of middle and upper Pliocene nonmarine conglomeratic sandstone, with a minor amount of siltstone and mudstone of the Ridge Basin group (Axelrod, 1950, pp. 165-168). A 3,000-foot section of continental upper Pliocene conglomerate and sandstone in the San Fernando reservoir area is described as the Sunshine Ranch member of the Pico formation (Hazzard, in Oakeshott, 1950, pp. 59-61).

In the Los Angeles basin approximately 60 percent of the oil produced has come from zones in the Repetto formation, and Pliocene zones are large producers in the eastern Ventura basin fields. Large tonnages of gypsite were mined from lower to middle Pliocene Anaverde shales southwest of Palmdale (Wallace, 1949, geologic map).

Quaternary sedimentary rocks generally consist of poorly consolidated, ill-sorted, dominantly nonmarine types. The principal Pleistocene formation in the eastern Ventura basin area is the Saugus. It is composed of continental conglomerates, sands, silts, and clays, with a maximum thickness of over 3,000 feet (Hill, 1930, p. 144). The Saugus formation is mostly lower Pleistocene in age, but part of it is late Pliocene (Kew, 1924, p. 89). Small tonnages of the marine lower Pleistocene Lomita marl have been quarried in the Palos Verdes Hills for agricultural purposes. Upper Pleistocene sediment, chiefly unconsolidated clay, sand, and gravel, accumulated in local basins formed during mid-Pleistocene time. Upper Pleistocene marine sediments are found only in the coastal plain area, and grade laterally into nonmarine sediments to the north, east, and south (Eckis, 1934, pp. 52-57). On the north margin of the Palos Verdes Hills and on the southern flank of the Puente Hills Pleistocene deposits are sources of sand produced for various commercial purposes.

Recent sediment is confined to poorly sorted, unconsolidated alluvial sand, gravel, and clay, with sand dunes on the west coast. Deformation of the early Quaternary sediments is locally severe, but more recent beds are relatively undisturbed. Quaternary deposits are the sources of the sand, gravel, and crushed rock produced in large tonnages, chiefly in San Fernando and San Gabriel Valleys. Recent sand dunes in El Segundo area are important sources of sand for various specialty purposes. Quaternary alluvial deposits of common clay along the Los Angeles River and in the coastal plain are sources of raw material for the heavy clay products industry.

Structural Features

In Los Angeles County the earth's crust has been deformed by folding, warping, and faulting. In the southern part of the county these structures characteristically trend northwestward, in the center of the county they are distinguished by an east-west trend, and in the desert region in the northern part of the county they trend both west and northwest (Jenkins, 1943, pp. 83-88). Most folding in the county is associated with faulting.

Faulting. The best known fault zone in Los Angeles County is the northwest-trending San Andreas, which crosses the northern edge of the county. This zone, in places as much as a mile wide, lies parallel to, and a little south of the approximate boundary between the Antelope Valley-Mojave Desert area on the northeast, and the Ridge Basin, Liebre Mountain area, Sierra Pelona, and San Gabriel Mountains to the southwest. Having one of the longest surface traces in the world, the principal break of the San Andreas rift extends for hundreds of miles northwest and southeast of the county. Displacement along the fault is primarily strike-slip in a right lateral sense, and is possibly of the order of several tens of miles since early Tertiary time (Noble, 1926, p. 420). Older rocks may have been displaced a few hundred miles by the fault (Hill and Dibblee, 1953, p. 445).

Another major northwest-trending structural feature is the San Gabriel fault zone, which crosses the approximate center of the county. This fault zone forms the southwest boundary of the Ridge Basin against the easternmost Ventura basin. The fault crosses the easternmost Ventura basin and then trends eastward through the central portion of the San Gabriel Mountains. Horizontal displacement of 15 to 25 miles in a right lateral sense is believed to have occurred along this fault since late Miocene time (Crowell, 1952c, pp. 2026, 2030).

South of the San Gabriel fault zone, and parallel to it, is the Sierra Madre system of discontinuous reverse faults that dip steeply north. This system lies along the southern boundary of the San Gabriel Mountains. Some of the faults in the system have been described by Miller (1928, pp. 200-214), Hill (1930, pp. 149-151), and Oakeshott (1937, pp. 236-242). The uplifted blocks of granitic and metamorphic rocks comprising the San Gabriel Mountains are weakened and shattered by numerous major and minor faults.

The Newport-Inglewood fault belt, extending southeast from Beverly Hills, across the Los Angeles basin, is economically important. Several major oil fields, including the Inglewood, Dominguez, Long Beach, and Seal Beach fields, are located on structures disposed along this belt. The relationship between the en echelon faults and folds along the belt is not conclusively established, but anticlinal domes in the Tertiary strata may have resulted from movement along a deeply buried fault in the basement rocks (Reed and Hollister, 1936, pp. 1671-1679). Fault movements along the Newport-Inglewood belt were responsible for the destructive Inglewood and Long Beach earthquakes of 1921 and 1933, respectively.

The Whittier fault, a steeply north-dipping reverse fault with about 7,000 feet of vertical displacement, and a horizontal offset of several thousand feet in a right-lateral sense, trends northwest along the Puente Hills in a southeast corner of the county (Kundert, 1952, pp. 11-12). Structures along this fault, sometimes shown as a northwestern extension of the Elsinore fault (Jenkins, 1938) are the sources of oil in the Whittier and Sansinena oil fields.

The Santa Monica Mountains are fractured by an intricate west-trending system of faults, localized mainly along the southern edge of the mountains. The eastern end of the Santa Susana Mountains, near the northern margin of the San Fernando Valley, is marked by the west-trending Santa Susana thrust fault which brings Tertiary and older rocks against Quaternary sediments.

Folding. A major westward-plunging anticlinal fold extends west along the center of the eastern Santa Monica Mountains, deforming Triassic (?) slate in the center of the mountains and Cretaceous-Eocene and Miocene sediments flanking the range (Hoots 1931, pl. 16). This fold is complicated by faulting. The open character of the fold is in strong contrast with the sharp asymmetrical folds in many Coast Ranges areas, and suggests origin by uplift rather than by lateral compressive forces (Hoots, 1931, pp. 83, 125-128). Folding and faulting in these mountains has been repeated several times since the Jurassic (?) granitic intrusion, but the major deformation took place in Quaternary time.

All Tertiary rocks of the Los Angeles basin have been subjected to the widespread mid-Pleistocene deforming forces which resulted in a wide variety of folded structures, most of them modified by faulting. Axes of folding generally trend northwest. Cross sections (Am. Assoc. Petroleum Geologists, 1952; Woodford, Shelton, and Moran, 1944) drawn northeast across the basin indicate a series of gentle open folds, with more intricate folding at the margins of the basin. Between the Palos Verdes Hills and the San Gabriel Mountains the sediments of the basin are folded into a series of gentle open anticlines and synclines, with local faulting and steepening of attitudes. Local structures are discussed in their relation to petroleum accumulation in the section on oil and gas, below.

San Gabriel Valley, essentially a gentle syncline, is the northeasternmost edge of the Tertiary Los Angeles basin, lying along the faulted front of the San Gabriel Mountains. San Fernando Valley, virtually a northwesterly continuation of the San Gabriel Valley beyond the Verdugo Mountains, is also essentially a syncline. Both valleys are partially filled with Quaternary alluvium. Folds and steeply north-dipping reverse faults along the northern border of the valleys complicate the structure.

In the easternmost Ventura basin the dominant feature is the southwestward-plunging, open, synclinal trough of the basin. On this feature is superimposed a series of roughly parallel open folds with varying dip of the strata (Sheller et al., 1952; Jahns, 1940, pp. 168-169). Faults, recurrently active throughout most of the Tertiary period, and depositional unconformities complicate the structure and are instrumental in the accumulation of oil from marine strata.

The dominant structural feature of the Ridge Basin area in the northwestern corner of the county is the northwest-plunging asymmetrical Ridge Basin syncline (Dehlinger, 1952, p. 9). The syncline lies in a wedge-shaped graben bounded mostly by the San Andreas, San Gabriel, and Liebre fault zones (Dehlinger, 1952, p. 4). The southern part of the Ridge Basin is not complicated by minor folds or faulting but along its northern edge it is disrupted by numerous faults and tight folds (Jennings, 1953, p. 14).

The Sierra Pelona (Simpson, 1934) is essentially an uplifted block bounded by faults and greatly broken in its interior by a multitude of smaller faults. Metamorphic rocks of the pre-Cambrian (?) Pelona schist series have been deformed in broad open folds and are flanked by Tertiary strata, indicating a profound unconformity.

Ocean Floor. The Pacific Ocean floor off Los Angeles County consists of a series of basins separated by submerged or partly submerged mountains (Emery, 1942; Shepard, 1941). Santa Catalina (Bailey, E. H., 1940; Smith, 1877, pp. 1-22) and San Clemente (Smith, 1898) Islands, and Palos Verdes Hills (Woodring, Bramlette, and Kew, 1946) are essentially tilted blocks, probably outlined by faults, uplifted and now projecting above sea level.

Three submarine canyons, probably early Pleistocene, cut the continental shelf opposite the Los Angeles County coast. Redondo Canyon heads directly off Redondo pier for a distance of 10 miles, Santa Monica Canyon extends seaward for 8 miles from a point 5 miles west of Venice, and Dume Canyon extends for 4 miles west of Point Dume. Gradients of these canyons range from 2.5 to 20 percent.

Lands Open to Mineral Entry

All valuable mineral deposits belonging to the United States, both surveyed and unsurveyed, and the lands in which they are found, are free and open to exploration, occupation, and purchase, except that aliens may not obtain patent, except as noted (Norman, 1952; see also Mineral lands and mining resources: Revised Statutes of the United States, Title XXXII, Chapter VI, section 2319).

Los Angeles County includes about 1,000 square miles of public land within the national forests, and less than 100 square miles of other public lands. Angeles National Forest, in covering about 25 percent of the county's area, embraces most of the San Gabriel Range and the Sierra Pelona, and much of the Ridge Basin. About 15 square miles of Los Padres National Forest adjoins the Angeles National Forest in the northwest corner of the county.

In general, public domain land within national forests is open to mineral location and entry, subject to the jurisdiction of the United States Forest Service. However, more than half of the national forest land in the county, nearly 600 square miles from Angeles National Forest, was withdrawn from mineral location or entry in 1928 "to conserve the water resources and to encourage reforestation of the watershed of Los Angeles County." * All government lands in specified sections throughout the national forest were withdrawn, but claims valid prior to passage of the act remain valid as long as requirements of mining law are met.

Prospecting is permitted on unclaimed lands throughout the national forest, on open and withdrawn land alike, except in dry seasons when certain parts of the forest are closed because of the fire hazard. If mineral deposits are discovered on withdrawn lands, the discoverer may petition the appropriate agency to have the mineralized areas restored to mineral location and entry. Claims are sometimes laid out on withdrawn lands, but they are not valid until the land is restored to mineral location and entry. Persons prospecting anywhere within the national forests should obtain permits from the Forest Service for such activities as removing timber, building roads, starting fires, and using explosives.

With the approval of the Federal Power Commission small areas in several parts of the county have been withdrawn from mining entry

* Public Law 578 (S. 4135) dated May 29, 1928.

*Mineral production of Los Angeles County, 1880-1951.**

Year	Gold, value	Silver, value	Petroleum		Natural gas		Asphalt, tons	Gypsum		Salt		Gems, value	Mineral water	
			Barrels	Value	M cu. ft.	Value		Tons	Value	Tons	Value		Gallons	Value
1880	$7,700	$66,300	[1]											
1881	13,000	39,000												
1882	17,000	24,000												
1883	20,000	25,000												
1884	40,000	11,000												
1885	22,500	1,945												
1886	21,500	6,750												
1887	25,000	25,000												
1888	20,000	10,000												
1889	38,203	97												
1890	74,320	7,266												
1891	40,759													
1892	219,204													
1893	14,200													
1894	34,500		475,650	$617,065				1,134	$11,340					
1895	23,330		979,695	732,817				3,790	37,820					
1896	35,468		953,734	812,800				960	9,180					
1897	40,698		1,327,011	1,327,011				1,900	17,250					
1898	21,300		1,462,871	1,462,871				2,500	18,500					
1899	13,132		1,409,356	1,409,356		$23,020	1,151	3,563	14,250				193,500	$5,805
1900	5,508		1,722,887	1,722,887		100,000	5,000	2,500	10,000					
1901	10,312		2,304,432	1,062,038	$1,500	152,838	10,000	3,500	35,500	6,650	$19,950			
1902	7,209		2,198,496	1,075,868		171,904	16,767			90	180			
1903	8,674	22	1,960,604	1,294,866		332,600	28,308	5,914	38,441	8,000	20,000		95,000	5,500
1904	12,402	73	2,190,000	1,289,910		307,068	30,425			7,560	24,480		125,750	7,084
1905	15,035	100	2,854,564	1,056,188		119,430	23,718	11,500	43,500	12,000	20,000		175,000	31,250
1906			2,814,000	908,800		259,200	25,920	21,000	69,000	12,000	36,000		85,465	5,128
1907			4,318,739	2,633,541		353,423	26,610	7,500	50,000	12,000	36,000		385,000	35,100
1908			6,244,347	4,082,052		250,000	25,000	12,000	75,000	12,000	48,000	$8,500	573,975	42,857
1909	864	2	5,409,392	3,513,192		516,500	40,740	10,000	50,000	10,000	30,000	9,500	266,315	19,988
1910			5,127,266	3,185,433	30,920	591,193	45,872			6,000	12,000	4,900	319,491	23,999
1911	[3]		4,924,288	3,313,972	15,208					7,592	16,113	5,000	229,019	17,256
1912	[4]		4,484,590	2,798,384	78,672					10,360	46,370	3,000	76,495	6,333
1913	2,322	27	4,143,690	2,672,680	1,287,794	77,578				10,000	40,000	2,500	255,095	15,140
1914			3,558,690	1,957,279	1,250,000	75,000				20,000	60,000	2,100	331,151	8,025
1915			2,931,098	1,843,661	1,729,035	120,783						700	350,171	29,491
1916			2,875,468	1,871,930	2,083,664	139,522				[8]		600	320,700	8,552
1917			4,669,583	5,491,430	1,670,476	194,793				[8]		300	188,368	16,902
1918			10,125,190	13,567,755	2,088,959	224,279				[8]		[8]	110,481	15,540
1919			15,076,633	20,805,754	4,148,476	458,812				[8]		[8]	125,400	8,787
1920		[8]	14,026,536	21,488,653	6,225,835	556,465				6,502	6,577		161,466	10,371

1921		[8]	12,395,605	25,795,254	6,944,277	638,936				[8]		[8]	264,468	13,314
1922		[8]	37,726,367	52,930,093	23,254,549	1,653,571				[8]			300,400	15,450
1923	714	6	158,665,[illegible]19	154,063,733	134,799,452	8,760,961				[8]			440,563	24,787
1924	751	5,515	119,027,428	147,474,953	122,838,521	9,191,395				[8]			1,889,285	88,942
1925	409	15,444	121,214,551	173,215,593	98,226,700	8,704,894				[8]			3,811,270	336,038
1926	94	42,658	105,826,337	174,084,324	91,054,793	8,965,307				[8]			4,026,465	200,459
1927	2,345	14,819	103,625,615	114,583,011	59,749,559	7,117,081				[8]			3,934,525	260,198
1928	2,187	20	120,549,303	126,709,373	110,432,906	9,058,485				[8]			10,929,535	538,110
1929	991	34	182,444,261	261,871,493	228,708,726	17,410,493				[8]			12,525,565	1,076,504
1930			114,533,366	148,549,776	156,470,411	14,065,968				[8]			23,695,673	2,152,928
1931	1,292	64	85,382,013	66,999,266	117,606,814	6,489,448				[8]			11,618,905	620,851
1932	6,691	13	78,361,176	67,390,611	83,699,705	5,379,497				[8]			8,011,766	938,652
1933	15,861	118	67,299,626	60,023,645	70,490,726	4,957,928				[8]			6,672,359	335,310
1934	57,924	535	60,297,000	59,711,578	58,220,382	3,421,320				[8]			8,202,017	479,710
1935	219,405	4,135	70,378,196	64,339,261	66,416,318	4,448,950				[8]			7,379,521	647,416
1936	177,030	1,893	72,629,599	70,758,648	62,611,713	4,689,852				[8]			9,126,944	435,842
1937	140,070	1,758	86,659,477	83,922,309	65,459,580	4,655,204				[8]			8,615,029	750,512
1938	171,710	1,220	106,545,794	113,407,606	73,790,818	5,451,390				[8]			8,398,855	349,028
1939	160,440	656	95,906,914	102,083,320	83,677,966	5,877,085				[8]			7,577,237	431,483
1940	258,440	2,103	90,696,857	85,342,723	98,109,911	6,462,762				[8]			7,150,460	475,089
1941	180,985	1,626	86,550,854	87,264,337	99,507,975	6,192,819				[8]			8,067,763	693,029
1942	16,765	163	87,248,536	90,620,837	91,719,975	6,186,796				[8]			8,281,287	283,745
1943	3,395	12	87,983,756	90,193,521	54,480,234	3,894,849				[8]			10,640,218	349,173
1944	2,975	12	88,646,069	95,872,140	52,806,375	3,843,357				[8]			11,563,991	383,317
1945	3,045	300	85,192,691	89,404,673	92,482,309	6,514,113				[8]			11,643,290	423,378
								Total: 87,761	Total: $479,781	Total: 140,754	Total: [8]$406,670			
								Natural gasoline		Liquid[1] petroleum gases				
								Barrels	Value	Barrels	Value			
1946	1,260	4	87,150,496	106,266,566	89,543,147	7,718,409							15,981,331	572,397
1947	1,680	5	91,897,000	164,496,000	98,435,000	8,586,000		7,127,000	$16,098,000	382,000	$491,000			
1948	7,525	33	91,096,000	223,002,000	102,783,000	11,588,000		7,496,000	23,411,000	477,000	1,225,000			
1949	8,715	111	93,421,000	216,151,000	94,664,000	10,661,000		6,071,000	19,467,000	1,112,000	3,237,000			
1950	10,290	88	96,870,000	210,898,000	104,796,000	10,742,000		6,065,088	18,472,000	734,609	1,316,000			
1951	10,850	160	99,237,746	229,431,437	115,969,311	15,334,043		6,314,214	19,782,000	706,463	1,274,000			
Totals	$2,268,979	[8]$310,069	2,996,027,662	$3,860,855,274	2,830,266,312	$230,619,733	279,511	33,073,302	$97,230,000	3,412,072	$7,543,000	[8]$45,200	210,484,254	$13,188,770

See last page of table for references.

Mineral production of Los Angeles County, 1880-1951.—Continued.*

Year	Brick		Pottery clay		Sandstone and serpentine		Sand and gravel[9]		Miscellaneous stone, value[2]	Miscellaneous and unapportioned		
	M	Value	Tons	Value	Cubic feet	Value	Tons	Value		Amount	Value	Substance
1880	----	----	----	----	----	----	----	----	----	----	----	
1881	----	----	----	----	----	----	----	----	----	----	----	
1882	----	----	----	----	----	----	----	----	----	----	----	
1883	----	----	----	----	----	----	----	----	----	----	----	
1884	----	----	----	----	----	----	----	----	----	----	----	
1885	----	----	----	----	----	----	----	----	----	----	----	
1886	----	----	----	----	----	----	----	----	----	----	----	
1887	----	----	----	----	----	----	----	----	----	----	----	
1888	----	----	----	----	----	----	----	----	----	----	----	
1889	----	----	----	----	----	----	----	----	----	----	----	
1890	----	----	----	----	----	----	----	----	----	----	----	
1891	----	----	----	----	----	----	----	----	----	----	----	
1892	----	----	----	----	----	----	----	----	----	----	----	
1893	----	----	----	----	----	----	----	----	----	----	----	
1894	7,500	$37,500	----	----	----	----	----	----	$5,500	9,500 bbls.	$10,800	Lime.
1895	45,800	235,000	----	----	----	----	----	----	47,500	----	----	
1896	27,478	179,290	----	----	[6]1,500	$6,000	----	----	30,000	----	----	
1897	36,868	228,290	----	----	[6]2,500	2,500	----	----	30,625	5 tons	200	Infusorial earth.
					10,500	5,250						
1898	25,908	188,386	50	$500	750	3,000	----	----	32,500	2 tons	50	Sulphur.
1899	23,385	147,400	----	----	[5]6,000	3,000	----	----	112,001	1,600 cu. ft.	2,000	Marble.
					[5]7,500	3,750						
1900	55,725	275,925	4,576	10,776	[6]350	2,000			24,352	----	----	
1901	44,435	264,825	130	390	[6]89	90	----	----	94,229	10 tons	19	Soapstone.
										100 tons	300	Mineral paint.
1902	52,776	335,670	890	890	----	----	----	----	105,047	14,400 lbs.	504	Lead.
										60 tons	360	Infusorial earth.
										1,736 tons	2,558	Glass sand.
1903	79,195	706,334	115	115	[5]2,163	9,734	----	----	118,185	219 tons	10,124	Soapstone.
					[5]29,211	13,145				10,000 bbls.	10,000	Lime.
1904	128,719	767,827	5,000	5,000	[6]200	2,310	----	----	83,826	709 tons	4,254	Glass sand.
										228 tons	2,315	Soapstone.
1905	109,563	853,810	30,533	16,066	[5]8,784	9,950	----	----	69,021	----	----	
					[5]19,080	9,540				18,000 bbls.	18,000	Lime.
1906	127,965	826,831	41,350	34,350	[6]847	1,694	----	----	176,558	50 tons	200	Infusorial earth.
					[5]21,196	19,076				849 lbs.	169	Copper.
1907	101,079	895,272	17,500	20,500	[6]1,000	3,000	----	----	36,904	1,000 cu. ft.	3,000	Marble.
										25,000 bbls.	25,000	Lime.
1908	108,414	800,163	25,934	55,274	[5]6,292	2,000	----	----	598,618	200 tons	8,000	Glass sand.
										1,800 tons	14,400	Glass sand.
1909	136,202	1,195,892	14,027	26,688	----	----	----	----	182,377	2,000 cu. ft.	6,000	Marble.
										----	842,530	Unapportioned, 1900-1909.

1910	148,723	1,361,653	450	800	----	----	----	----	324,091	40 tons	320	Infusorial earth.
										60 tons	720	Feldspar.
										80 tons	200	Glass sand.
										1,600 cu. ft.	4,800	Marble.
1911	160,259	1,442,913	15,650	41,025	----	----	----	----	553,076	1,100 cu. ft.	3,300	Marble.
1912	174,862	1,692,258	11,929	12,028	----	----	----	----	955,668	1,800 tons	1,800	Glass sand.
1913	204,912	1,752,106	7,425	20,135	----	----	----	----	1,008,810	1,800 tons	2,000	Glass sand.
										----	240,000	Other minerals.
1914	133,557	1,244,971	8,263	14,566	----	----	----	----	953,434	13,203 tons	349,669	Borax.
										10 tons	460	Potash.
1915	88,669	820,312	6,507	1,511	----	----	----	----	1,022,134	----	330,020	Barite, borax, potash.
1916	82,005	760,912	6,233	10,549	----	----	----	----	971,153	1,864 tons	324,769	Potash.
										612 tons	1,684	Silica.
										----	373,374	Borax, copper, graphite, salt.
1917	and tile	939,081	6,276	10,321	8	----	----	----	608,026	1,710 tons	400,902	Potash.
										----	542,768	Borax, graphite, magnesium chloride, salt, silica, serpentine, talc.
1918	43,381	668,676	12,634	11,820	8	----	----	----	547,190	18,630 tons	121,903	Building tile.
										2,380 tons	462,600	Potash.
										----	386,865	Borax, gems, graphite, magnesium chloride, manganese, salt, serpentine.
1919	and tile	1,185,154	11,329	33,343	----	----	----	----	715,524	----	399,007	Borax, gems, graphite, magnesium salts, manganese, salt.
1920	127,854	2,333,941	18,684	91,763	----	----	----	----	1,704,951	27,954 tons	308,476	Building tile.
										----	473,966	Borax, copper, gold, graphite, infusorial earth, lead, magnesium salts, silver.
1921	and tile	3,208,448	29,055	62,866	----	----	----	----	1,763,180	----	222,943	Borax, gems, gold, graphite, limestone, magnesium chloride, salt, silver.
1922	240,424	4,190,485	54,924	66,519	----	----	----	----	3,390,477	39,095 tons	397,136	Building tile.
										12,096 tons	35,168	Limestone.
										----	72,772	Borates, gold, graphite, magnesium salts, salt, silver.
1923	310,897	5,307,968	128,825	59,272	----	----	----	----	5,408,808	----	40,000	Building stone.
										53,199 tons	522,890	Building tile
										2,717 tons	8,779	Limestone marl.
										----	169,541	Borates, diatomaceous earth, magnesium chloride, salt, silica, soapstone.
1924	301,957	5,030,259	84,065	132,855	----	----	----	----	5,923,329	46,941 tons	454,728	Building tile (hollow).
										----	117,982	Copper, building stone (tuff), diatomaceous earth, lead, limestone, magnesium chloride, salt.
1925	196,955	3,300,748	217,707	106,817	----	----	----	----	6,978,605	44,345 tons	426,178	Building tile (hollow).
										----	95,274	Copper, lead, limestone, magnesium chloride, salt, sandstone, zinc.
1926	238,326	2,954,067	86,767	99,076	----	----	----	----	7,472,884	21,471 tons	192,408	Building tile (hollow).
										1,104,507 lbs.	88,361	Lead.
										2,564,188 lbs.	192,314	Zinc.
										----	66,974	Building stone (tuff), limestone (marl), salt.
1927	214,332	2,714,398	147,621	206,175	----	----	----	----	6,292,078	28,950 tons	288,471	Building tile (hollow).
										312,645 lbs.	19,697	Lead.
										----	334,168	Copper, graphite, diatomaceous earth, limestone, magnesite, salt, titanium, zinc.

Mineral production of Los Angeles County, 1880-1951.—Continued.*

Year	Brick		Pottery clay		Sandstone and serpentine		Sand and gravel[9]		Miscellaneous stone, value[2]	Miscellaneous and unapportioned		
	M	Value	Tons	Value	Cubic feet	Value	Tons	Value		Amount	Value	Substance
1928	148,392	2,191,943	99,781	55,539	[8]	----	----	----	5,622,815	29,302 tons	577,397	Hollow building tile.
										9,350 cu. ft.	3,240	Granite.
										----	76,879	Diatomite, lead, limestone, salt, sandstone, titanium.
1929	199,260	2,473,675	88,066	49,304	----	20,940	----	----	5,335,300	18,698 tons	281,695	Hollow building tile.
										1,981 lbs.	349	Copper.
										----	47,497	Granite, limestone, marble, soapstone, salt.
1930	172,468	1,677,406	78,643	70,693	----	22,292	----	----	4,731,302	28,783 tons	198,478	Hollow building tile.
										----	147,486	Diatomite, granite, lead, salt, soapstone, paving blocks.
1931	85,593	907,350	27,972	25,359	----	1,780	----	----	3,010,537	11,537 tons	95,357	Hollow building tile.
										2,245 lbs.	83	Lead.
										----	1,318,510	Bentonite, cement, diatomite, granite, iodine, salt.
1932	58,099	747,301	38,452	21,978	[8]	----	----	----	1,990,053	6,937 tons	54,740	Hollow building tile.
										----	191,579	Diatomite, lead, graphite, salt, sandstone.
1933	40,100	639,854	14,195	10,142	----	8,725	----	----	1,841,946	3,410 tons	19,832	Hollow building tile.
										808 lbs.	52	Copper.
										2,006 lbs.	74	Lead.
										----	931,807	Diatomite, dolomite, graphite, iodine, salt, soapstone.
1934	30,739	685,611	13,763	7,772	----	8,250	----	----	1,220,639	3,478 tons	24,960	Hollow building tile.
										517 lbs.	41	Copper.
										355,279 lbs.	423,016	Iodine.
										4,008 lbs.	148	Lead.
										----	317,723	Unapportioned.
1935	38,522	850,415	18,118	11,829	----	4,578	----	----	1,135,068	1,164 tons	11,193	Hollow building tile.
										3,885 lbs.	322	Copper.
										----	476,418	Diatomite, graphite, iodine, lead, salt.
1936	72,794	1,008,038	34,207	23,318	----	[8]	----	----	8,542,619	4,517 tons	32,005	Hollow building tile.
										----	558,187	Copper, diatomite, granite, iodine, limestone, marble, salt, slate, soapstone.
1937	80,400	1,586,821	17,828	15,083	----	[8]	----	----	8,655,018	6,355 tons	45,122	Hollow building tile.
										7,046 lbs.	416	Lead.
										----	565,295	Copper, diatomite, dolomite, granite, limestone, iodine, marble, salt, sandstone, slate, soapstone.
1938	60,367	1,206,092	30,766	55,605	----	----	----	----	3,836,394	3,022 tons	31,141	Hollow building tile.
										2,128 lbs.	209	Copper.
										----	516,659	Bentonite, diatomite, granite, iodine, limestone, lead, salt, slate, soapstone.
1939	76,290	1,377,239	17,836	46,272	----	[8]	----	----	2,921,561	1,862 tons	20,393	Hollow building tile.
										2,936 lbs.	305	Copper.
										2,183 tons	103	Lead.
										----	658,789	Diatomite, dolomite, granite, iodine, limestone, salt, slate, sandstone, soapstone, titanium.

1940	58,924	1,187,040	26,046	18,306		8			3,569,457	3,446 tons	32,238	Hollow building tile.
										3,138 lbs.	355	Copper.
											835,231	Diatomite, dolomite, granite, iodine, limestone, marble, salt, sandstone, slate, titanium.
1941	51,096	1,408,213	67,283	127,370					4,865,007	3,160 tons	38,212	Hollow building tile.
										1,111 lbs.	131	Copper.
											885,466	Lead, diatomite, dolomite, granite, iodine, limestone, marble, salt, titanium.
1942	102,751	2,679,889	30,480	67,272		8			5,087,331	3,462 tons	24,910	Hollow building tile.
											1,142,870	Cement, copper, diatomite, iodine, lead, limestone, salt, sandstone, titanium.
1943	55,200	2,046,334	39,910	53,454					2,808,592	1,587 tons	15,784	Hollow building tile.
											1,323,131	Cement, copper, diatomite, dolomite, iodine, limestone, salt, silica (ganister), titanium.
1944		2,065,468	61,640	85,007					4,596,097		1,289,781	Cement, diatomite, iodine, salt, titanium ore.
1945		1,664,186	54,307	60,518					4,193,004		1,388,610	Diatomite, iodine, salt.
1946	86,661	2,564,659	78,182	179,247		8			6,100,968		1,543,300	Diatomite, iodine, iron ore, sandstone, titanium minerals.
			Total: 1,831,924	Total: $2,135,958								
			[7]Raw clay									
1947			477,011	436,146			11,088,519	6,866,923	3,167,650		3,386,229	Cement, diatomite, iodine, lime, silica (quartz), soapstone.
1948			491,167	368,784			11,909,517	8,085,435	4,323,469		3,881,047	Cement, diatomite, iodine, soapstone, titanium concentrates.
1949			402,853	299,810			11,020,272	6,848,873	2,511,510		3,509,170	Cement, diatomite, iodine, soapstone, titanium concentrates.
1950			841,747	373,359			15,127,334	9,835,428	2,662,283		4,027,960	Cement, diatomite, granite, iodine, soapstone, titanium concentrates.
1951			466,820	381,148			15,820,669	11,012,775	2,278,376		4,610,810	Cement, diatomite, granite, iodine, soapstone, titanium concentrates.
			Total: 2,319,598	Total: $1,859,247								
Totals		$77,814,209				[8]$165,604	64,966,311	$42,649,434	$143,347,912		$45,008,805	

Grand total value: $4,525,928,645.

[1] Commercial production of petroleum in Los Angeles began at least as early as 1874, in the Newhall district, but detailed county segregations are not available for the early years.
[2] Includes granite, crushed rock, rubble, paving blocks. Sand, gravel included before 1947.
[3] Included in Riverside County production.
[4] Included in Monterey County production.
[5] Sandstone.
[6] Serpentine.
[7] Clay production since 1946 given as "raw clay."
[8] See under "Unapportioned."
[9] Included in "Miscellaneous stone" before 1947.
* Statistics for years 1880-1943 taken from California Div. Mines Bull. 130, 145.

for use as power sites or power transmission sites. The Los Angeles County Flood Control District holds easements and leased rights in the vicinity of flood control dams in different parts of the county. Entry to lands adjacent to Pacoima, Big Tujunga, Santa Anita, San Gabriel No. 1 and No. 2, Sawpit, Big Dalton, and San Dimas dams in the national forest is subject to approval of the Flood Control District. These areas are already included in those withdrawn under Public Law 578. Other flood-control projects in the county are on lands not otherwise available to mining entry.

To determine whether it is possible to stake a claim on a particular mineral deposit, the status of the land must be ascertained. It is essential that the exact location and township description of the parcel of land be known to the person requesting information. Status of all lands, public and private, in national forests may be obtained from the district offices of the Forest Service, 1443 Federal Building, Los Angeles 12, for the Angeles National Forest, and Federal Building, Santa Barbara, for the Los Padres National Forest. Ownership of all land in the county may be ascertained through the office of the County Assessor, Hall of Justice, 221 North Temple, Los Angeles. Status of unpatented mining claims may be ascertained through the office of the County Recorder, Hall of Records, 220 North Broadway, Los Angeles. Public lands outside of national forests are under the jurisdiction of the U. S. Bureau of Land Management, 1512 Federal Building, Los Angeles 12, California.

MINERAL RESOURCES

In 1950 Los Angeles County ranked first in mineral production among California counties. Total production to 1950 also is the greatest for any county in the state.

The outstanding record of mineral wealth yielded by Los Angeles County has been achieved through enormous production of petroleum from the Los Angeles and eastern Ventura basins. In 1950, oil and natural gas produced in the county were valued at $230,686,000. In the same year the sand and gravel produced was valued at $9,835,428 and the stone produced at $2,662,283. A value of $4,027,000 was attributed to the combined production of cement, diatomite, granite, iodine, soapstone, and titanium concentrates.

Mining properties in Los Angeles County are described below in alphabetical order. The first section is devoted to metallic minerals and the second describes nonmetallic minerals. A third section describes the petroleum resources and oil fields in Los Angeles County. A tabulation of mining properties is included at the end of this report.

Metals

Antimony

No production of antimony has been recorded in Los Angeles County. Antimony was reported in 1906 to have been found in the vicinity of Lancaster (Aubury, 1906, p. 359) and at a locality 7 miles from Los Angeles, but no details were given. Stibnite (antimony sulfide) is reported to be associated with complex sulfide minerals on the Ore Hill (Denver) claims in Pacoima Canyon (see lead-silver-zinc section in tabulated index).

Chromium

Chromite has never been mined in Los Angeles County. Float boulders weighing as much as 100 pounds and carrying 42 percent chromium oxide (Cr_2O_3) have been reported in a zone of serpentinized peridotite north of Bouquet Canyon, about 13 miles north of Saugus (Tucker, 1927b, p. 288). Microscopic examination of a basic gabbro from the Little Tujunga quadrangle in the western San Gabriel Mountains revealed the presence of chrome spinel (Oakeshott, 1937, p. 243). According to Murdoch and Webb (1948, p. 104) "reports of occurrences of chromite from near Acton and Harold in Soledad Canyon are undoubtedly due to mis-identification of ilmenite which is so abundant as float and lode in this section." Brief descriptions of reported chromite localities are in the tabulated index of this report.

Cobalt

Cobalt has been noted in the complex sulfide minerals on the Ore Hill (Denver) claims in Pacoima Canyon and in the Kelsey mine 5 miles north of Azusa (see lead-silver-zinc section in tabulated index). Recovery of cobalt at these locations has not been attempted.

Copper

Small amounts of copper have been produced from several mines in Los Angeles County. Most of the known copper deposits are limited in extent and of too low a grade to be profitably mined at present. A brief description of these mines is in the tabulated index.

Gold

Gold was discovered in Los Angeles County in the early 1800s, well in advance of the more famous discovery at Sutter's Mill by James Marshall in 1848. Data as to the exact date, place, and circumstances of the discovery conflict. Apparently placers were worked in the region just west of Castaic (Casteca), about 35 airline miles northwest of central Los Angeles, in the period 1834 to 1838. The Santa Felicia (Santa Filiciana, San Feliciano) Canyon area is frequently mentioned as the site of the first actual discovery. Merrill (1919, p. 473) states that the deposits were first worked by priests from the nearby San Fernando and San Buena Ventura missions. Cutter (1948, p. 13) places the discovery in 1841 or 1842 and credits it to a cattle rancher who discovered gold on his knife blade after digging up a wild onion for lunch. A commemorative plaque in Placerita Canyon, about 11 miles southeast of Castaic, states that the first gold in California was discovered at that spot on March 9, 1842.

Nevertheless, local residents and later experienced Mexican miners from Sonora diligently worked the placer deposits of San Francisquito, Placerita, Castaic, and Santa Felicia Canyons, developing dry-washing methods to overcome the lack of water in the area. During 1857 and 1858 not less than 6,000 people were mining gold in the area (Merrill, 1919, p. 474). Production figures are not recorded, but Hubert H. Bancroft, the California historian, states that 2,000 ounces valued at $38,000 were recovered by December 1843, and other estimates range as high as $100,000 for the first 2 years of the rush. This gold rush was not widely publicized by the Mexican authorities, and it subsided

naturally after a few years, apparently because mining difficulties made profitable recovery possible only to experienced miners, and the easily recovered gold was soon nearly exhausted (Cutter, 1948, p. 13).

In the 1800s and early 1900s placer and lode deposits of gold were subsequently mined in many places in the county. Active districts included the lode mines near Acton and Neenach, placers in the vicinity of Bouquet and Texas Canyons near Saugus, and various lode and placer deposits in the San Gabriel Mountains, the most notable being in eastern San Gabriel Canyon and near Mount Baldy. Of the $2\frac{1}{2}$ million dollar gold output recorded in the county since 1880, more than half has come from Governor lode mine near Acton. More than 60 placer properties, mostly in the Saugus and San Gabriel districts, have yielded a total of nearly 20,000 ounces of gold; these properties were most active in the late 1800's and the 1930's. A comparable number of lode mines have a reported, combined production of nearly 50,000 ounces, also obtained in the late 1800's and 1930's. These are chiefly in the Acton (Cedar), San Gabriel, and Neenach districts. Since 1942 relatively little gold has been produced. The only recorded production in 1952 was a by-product of a sand and gravel operation in Azusa (see below).

A major deterrent to profitable placer mining in most areas of the county is the scarcity of water, both for hydraulicking and for operating sluice boxes. There are almost no available sources from which water may be practicably brought by flume to mine sites. This circumstance has forced placer miners in most of the county to resort to the less efficient dry recovery methods. Lack of water has also hindered the establishment of mills at several lode mines.

Near the town of Acton, about 29 airline miles north of central Los Angeles, are the mines of the Cedar and Mount Gleason mining districts. Mines in this region exploit gold-bearing veins in basic intrusive and metamorphic rocks of the Pelona schist series and San Gabriel complex. The deposits occur in faulted and fractured rocks. Chlorite-rich zones occur along some fault planes. Ore is pyritiferous but generally free-milling, and occurs in groups of small veins 1 to 6 feet wide rather than in wide continuous veins.

The principal mines of the Cedar district were the Governor (New York) and the Red Rover, but minor production came from a score or more smaller mines. The principal mines of the Mount Gleason district were the Los Padre and Mount Gleason. The Mount Gleason district yielded relatively minor amounts of gold. None of the mines in the Acton area, except the Hi-Grade (see below), has been active in the past decade.

Gold was reported produced from the Antelope Valley foothills just south of Neenach as early as 1899, but the bulk of production, totalling well over $100,000 (Wiese, 1950, p. 47), was obtained in the period 1935-38. At this time the discovery of high-grade ore at the Rogers and Gentry mine stimulated much excitement, prospecting, and mining in the vicinity. The Rogers and Gentry was the first and most active mine in the area but several smaller operations were active nearby. The Brite (Sampson, 1937, p. 179; Tucker, 1934, pp. 318-319) lease, about 1,200 feet southeast of the Rogers and Gentry property, on the same vein system, was developed by an 80-foot inclined shaft with a 200-

foot drift at the bottom. This property yielded $35,000 in gold from ore carrying about $40 in gold per ton. The Russell and Myler (Ventura-Neenach) lease (Sampson, 1937, p. 179) adjacent to the Brite is reported to have had a large production. It was developed by a 200-foot inclined shaft and various workings on the 100- and 200-foot levels, connecting with the Brite workings. Just south of the Brite lease the Ragan and Williams lease (Sampson, 1937, p. 189) was active. A tunnel was driven 250 feet towards the Brite ground but work ceased before any ore was encountered.

Still farther southeast, the Tuttle (Gold Dyke) lease (Sampson, 1937, pp. 183, 193) was also active, but its reported output is only a few ounces of gold. Gold here was in a pegmatite dike mined through a 70-foot shaft with workings at the 15-, 30-, and 45-foot levels. This was the only location among the many spots investigated by the Rivera Mining Company (Sampson, 1937, p. 190) that yielded ore.

In addition to the placer deposits worked northwest of Saugus during the original gold rush, scores of other placer operations have been active within a 10-mile radius of that town. Deposits have been worked in Haskell, Dry, Bouquet, Texas, Mint, Soledad, and Placerita Canyons as well as in many smaller stream courses. All operations have been intermittent and of short duration, principally because of insufficient water. Actual production is undetermined, but available reports indicate that few if any of the later placer mines in this region have yielded gold valued at more than several hundred dollars.

The San Gabriel River area has been the scene of intermittent but notable placer mining activity during various periods since prior to 1848. (Merrill, 1919, p. 475; Peck, 1938). Operations were concentrated along the gravel bars of the East Fork of the San Gabriel River to about 5 miles north of Camp Bonita, and for several miles eastward in Cattle and Coldwater Canyons. In 1861 the Wells Fargo Express Company shipped an average of $12,000 a month in gold nuggets from San Gabriel Canyon sources to San Francisco. In 1862 floods destroyed most of the valley-bottom placer mining installations, but in the early 1870s hydraulic operations recovered about $1,000 per month from canyon-side deposits. Flumes as much as 6 miles in length brought water along the canyon walls and delivered it under pressure to the mines. In 1874 it was reported that in the preceding 18 years Ducommon and Jones purchased over two million dollars in gold dust from the placer claims of the San Gabriel River (Peck, 1938, pp. 6, 7). The later 1800s and early 1900s were a period of intermittent production in the region, but debris laws and diminished reserves of placer ground discouraged mining activity. The catastrophic floods of March 1938 finally obliterated most of the traces of early placer mining in the canyon. Little if any gold has been mined in the North and West Forks of the San Gabriel River.

Lode mines in this region are located chiefly on quartz veins cutting meta-igneous rocks, and various metamorphic rocks of the eastern San Gabriel complex. The veins are generally less than 3 feet wide, discontinuous in strike, oxidized near the surface, and ore in them is irregularly distributed.

Of the six larger lode mines in this region, two, the Big Horn and the Allison, have been the principal sources of gold. A total of about

50,000 ounces of gold and a lesser quantity of silver has been produced in the lode mines of the region. The Big Horn and Native Son mines, north of San Antonio Ridge, were active principally from 1903 to 1908; there was minor activity at the Big Horn in the mid-1930s. The Allison, Baldora, Gold Dollar, and Stanley (renamed Chuckawala) south of San Antonio ridge, were active mainly in the 1930s. Activities at these mines during the past decade have been spasmodic, and the mines have for the most part fallen into disrepair.

The bottom lands of the East Fork of the San Gabriel River were taken up in a virtually continuous series of claims extending from the confluence with the West Fork northeast almost to the headwater divide, San Antonio Ridge. A number of claims in this area are still valid or have been patented, but the entire East Fork is in the area withdrawn from mining entry since 1928.

Gold still exists in the gravels of the San Gabriel River bed, and small amounts are recovered by small-scale placer methods. Besides claimholders, who mine intermittently, large numbers of picnickers and visitors to the area engage in panning and small-scale sluicing on weekends. The purpose of the weekend placering is primarily recreational rather than commercial. A length of river bed over a mile long between Camp Bonita and Williams Canyon is available throughout the year for recreational mining activity. After fire restrictions are lifted in the fall, limited unclaimed areas upstream from Camp Bonita are open to prospecting. Persons desiring to mine in this region should contact the District Ranger of the Mt. Baldy district, 110 Wabash Avenue, Glendora, for details.

Outside of the above-named districts a few mines and many prospects exist elsewhere in the county. Among the best known of these are the Dawn and Monte Cristo mines in the San Gabriel Mountains, the Double Eagle mine in the Sierra Pelona, and the Gillette mine on Liebre Mountain.

Descriptions of several recently active properties follow. See tabulated index for details of other gold mining properties.

Black Cargo Mine. Location: sec. 13, T. 3 N., R. 12 W., S.B.M., (projected), in the central San Gabriel Mountains, about 10 airline miles southeast of Acton, and about 14 airline miles north of Pasadena. Ownership: C. C. Schey and P. N. Maynard, Box 100, Route 3, Palmdale, own 8 unpatented claims and one millsite.

The Black Cargo is a small gold mine worked prior to 1900 when the ore was milled in arrastres. This work is believed by the present owners to have been contemporaneous with that of the adjoining Monte Cristo mine. Late in 1952 the present owners, who have held the property since 1935, began mill tests on the old tailings. The underground workings, however, have not been reactivated.

Free gold occurs in quartz veins in anorthosite and basic metamorphic rocks of the San Gabriel Mountains. The veins contain malachite stains and limonitic residues of oxidized iron and copper sulfides. At the surface the principal vein is 2 to 5 feet wide, strikes N. 15° W., and dips 70° SW. At lower levels two narrower veins strike N. 20° W. and N. 5° W. and dip 60° SW. The veins are slightly offset by at least three faults.

The mine workings consist of two 45-foot shafts and four adits distributed through a vertical distance of about 250 feet. The adits are driven southeastward along the veins and total about 700 feet in length. The most extensive, although irregular, workings are on the third level, and total about 300 feet. Two glory holes and several raises connect underground workings with the surface.

A gravity 24-bucket cable tramway, 2,000 feet long was built from the mine to a mill. In 1952 after the tramway proved unfeasible, a road 3,500 feet long was built from the mill to the mine. The mill consists of a Brodies 10 by 18-inch jaw crusher, a Smith #3 five-stamp crusher, about 32 feet of copper amalgamation plate, including 6 perforated plates, and 20 feet of rubber matting sluice box. Water is pumped about 20 feet from the stream below the mill. Since 1952 there has been only test production. The present owners report assays of dump material average $38 per ton in gold, and assays are as high as $96 in gold per ton for ore in place.

Governor (New York) Mine. Location: sec. 21, 23, 24, T. 5 N., R. 13 W., S.B.M., about 3¾ airline miles northwest of Acton. Ownership: Thomas A. and Earl F. Woods, and Mrs. Charles H. McWilliams, 4200 Bandini Boulevard, Los Angeles 23, California, own 80 acres of patented land and several unpatented claims.

The Governor mine, with the largest gold output of any mine in Los Angeles County, has a yield valued at more than $1,500,000.* The total recorded output of gold in the county is more than $2,250,000 (Sampson, 1949, p. 63).

Free gold occurs with iron sulfides in a quartz vein cutting quartz diorite of the Pelona schist series. The vein strikes N. 20° W., dips 75° NE., and ranges in width from 4 to 18 feet. Average width of the vein is slightly greater than 4 feet. Faults with as much as 25 feet displacement offset the lower levels of the vein toward the west. Post-mineral dikes also cut and displace the vein.

The mine workings are the most extensive of any gold mine in the county. They include a vertical shaft 1000 feet deep, through which ore was removed via the 450-foot main haulage adit which is the 100-foot level. Drifts as much as 500 feet in total length extend in each direction from the shaft along the vein at vertical intervals of 100 feet. During the most recent operation of the mine two 200-foot winzes were sunk 450 feet apart from the 1,000 foot level north of the shaft. These were reported to have developed ore 4½ feet wide to the bottom.† Faulting is more pronounced at the lowest levels. In 1952 the mine was accessible only to the 500-foot level and was flooded below the 700-foot level.

The deposit was first mined in the 1880s as the New York mine, yielding over $100,000 in gold. A five-stamp mill was then in operation. In 1897 the vein was lost and the mine closed. In 1932 it was reopened by Francis Gage of the Governor Mines Company, who renamed it the Governor. It operated continuously until 1942 but its period of greatest productivity was from 1937 to 1940 when rich ore-bodies were mined on the 400-foot level.

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* Gage, Francis, Personal communication, 1952.
† Woods, E. F., Personal communication, 1953.

Assays of several hundred dollars in gold per ton were made in high-grade shoots throughout the mine. Minor amounts of silver were present. Average values for much of the operating history of the mine exceeded $12 per ton over the total width of the vein. On the 400-foot level the ore returned $40 a ton over an 18-foot width of vein. Mining costs averaged about $4.50 per ton since 1932.†

Ore was crushed at the mine, then trucked several miles to be milled at the Governor mill at Acton. The first mill, at Acton Junction, reached a capacity of 60 tons daily in 1937. South of Acton a larger mill was then installed. By 1940, production had increased to 140 tons of ore mined and milled every 24 hours. Ores from other mines, including the Red Rover and the Puritan, were treated in this mill. Machinery included a jaw crusher and rolls at the mine, and a ball mill, three-compartment amalgamation trap, classifier, conditioner, and flotation cells (three rougher and one cleaner) at the mill. Mill recovery of 94 percent was achieved.*

An attempt to cyanide the mill tailings was not profitable. The mill was dismantled and sold at auction in 1950, and a cleanup of mill concentrates made.

Hi-Grade (Don) Mine. Location: secs. 26 and 27, T. 5 N., R. 13 W., S.B.M., in low hills of the Acton mining district, about half a mile south of U. S. Highway 6 and about 2 airline miles northwest of Acton. Ownership: Francis Gage, 1557 South Fairfax Avenue, Los Angeles, California, owns three claims formerly belonging to O. L. Corbin, 121 Carlton Street, Pasadena, and leases 25 acres of patented land from Edward D. Miles.

The Don mine, renamed the Hi-Grade in 1938, is a small gold mine that yielded ore valued at about $10,000 while active during several intervals from 1936 to 1951. Since 1951 the mine has been inactive, but the mill is used as a testing plant for gold and tungsten ores.

Gold is present in three or more roughly parallel quartz veins, which strike N. 10°-20° W. and dip as much as 60° SW. Country rock is deeply weathered granodiorite of the Pelona schist series, which is abundantly exposed in the area. The veins range from a few inches to 1½ feet in width and contain free gold, chalcocite, cuprite, and bornite. Basic dikes in the granitic rock cut the veins, as do several minor faults, but there is little displacement of the veins. Values exceeding $50 per ton in gold are reported in several places.*

The principal workings are on the Don No. 1 claim. Details of the early operation of the mine are undetermined, but previous to 1937 a shaft was sunk 80 feet on a 70° incline with 60- and 40-foot drifts extending southeast on the 30- and 80-foot levels respectively. Also present were about 350 feet of level workings with a portal about 300 feet southeast of the shaft. One ore shipment during this period is reported to have returned $40 per ton (Sampson, 1937, p. 181).

Since 1938, when Gage commenced operating the property as the Hi-Grade mine, the shaft has been deepened to 210 feet, and several hundred feet of drifts have been driven on the 210, 150, 118, and 80-foot levels. On the 118-foot level the vein is followed 125 feet north and 50 feet south of the shaft. Several hundred tons of ore were mined,

† Gage, Francis, Personal communication, 1952.
* Gage, Francis, Personal communication, 1953.

mainly in 1941 and from 1948 to 1951. Ore was stoped chiefly on the 100-foot level and between the 150- and 118-foot levels.

A 20-ton mill consisting of jaw crusher, ball-mill, classifier, plates, and tables was erected at the shaft in 1949, its source of water being the partially flooded mine shaft.

In mid-1953 a portion of the Hi-Grade property was leased to William M. Reid, Route 1, Saugus, who began mining a newly discovered parallel quartz vein 120 feet north of the Hi-Grade vein. The new vein, from 3 to 9 inches wide, was exposed by a dragline to a maximum depth of about 20 feet for about 60 feet along its strike. A shaft was also begun on the vein.

Monte Cristo (Monte Christo, West Vein lease) Mine. Location: secs. 12 and 13, T. 3 N., R. 12 W., S.B.M. (projected), on Monte Cristo Creek in the central San Gabriel Mountains, about 10 airline miles southeast of Acton, and about 14 airline miles north of Pasadena. Ownership: Mr. and Mrs. James Walters and Samuel G. Hooper, 4024 Cartwright, North Hollywood, California, own 19 unpatented claims, one patented claim, and one patented millsite.

The Monte Cristo gold mine was active during several periods from the late 1800s to 1942 when it was last shut down. A total yield of $70,000 was reported in 1927 (Tucker, 1927b, p. 294), and several hundred tons of ore have been mined since. Minor amounts of silver also were recovered.

Ore has been recovered from two groups of quartz veins, cutting granitic rock, about 1,000 feet apart. The eastern group has been the most extensively worked. Four approximately parallel veins range from 2 to 6 feet in width, strike about N. 20° W., and dip 80° E. They have been developed by two 425-foot adits 120 feet apart vertically, joined by a 130-foot raise. Shorter raises, drifts, and winzes extend these openings. Four ore shoots about 35 feet long and 2½ to 3 feet wide were mined to the surface from the upper adit. Above the upper adit the ore was free milling, being strongly oxidized and containing small amounts of pyrite. Ore found at the lower level is strongly pyritic and not amenable to amalgamation, although it is reported (Tucker, 1927b, p. 294) to carry $10 per ton in gold.

In the western group the main quartz vein is as wide as 7 feet, strikes N. 5° W. and dips 80° E. It is said to contain pyrite, marcasite, chalcopyrite, and a minor fraction of sphalerite (Sampson, 1937, p. 187). Open cuts and shallow workings expose the vein for about 3,000 feet along the surface. It is explored by adits 130 and 90 feet long and 50 feet apart vertically, and by appended minor workings. Ore removed from one small stope was valued at $18 to $40 per ton.

Except for a brief period, about 1936 and 1937, when each group of veins was leased to a different operator, the mine has been worked as a single unit. The mine was active in 1900 and 1901, from 1923 to 1928, and intermittently from 1935 to 1942. During most of this period, F. W. Carlisle of Palmdale owned the property. It was worked both by the owner and by lessees. On Carlisle's death in 1946 control was transferred to the present owners who are maintaining the property.

Red Rover Mine. Location: secs. 22 and 23, T. 5 N., R. 13 W., S.B.M., about 4 airline miles northwest of Acton and about one mile

north of Highway 6. Ownership: Thomas A. and Earl F. Woods, and Mrs. Charles H. McWilliams, 4200 Bandini Boulevard, Los Angeles 23, California, own four unpatented claims.

The Red Rover, one of the older gold mines of Los Angeles County, was most active prior to 1900. It has been operated under various ownerships at intervals since the 1870s, one figure for its total production being $550,000.* No ore has been mined since 1940; it is unlikely that the underground workings were accessible in 1953.

The mine area is underlain by dark weathered dioritic and gabbroic rock. The deposit consists of a gold-bearing quartz vein, 3 to 5 feet in width, striking about N. 20° W. and dipping steeply westward. Ore consisted of free gold in the presence of pyrite, chalcopyrite, and iron oxides. Telluride ore, chiefly the mineral sylvanite, was reported milled in the most recent operation.*

Workings consist of six shafts disposed over about a quarter of a mile along the strike of the vein. The main shafts are 650, 535, and 400 feet deep, the rest are from 100 to 150 feet deep. The 650-foot shaft had been filled by 1912, and in 1952 only the 400-foot shaft and minor workings were left unfilled.

Old reports indicate that the mine was active in the early 1870s when the ore was hauled by oxen to San Pedro for shipment to Mexico to be treated. Later, ore was shipped by boat to San Francisco for treatment. During the 1890s and in 1912 the mine was active to an undetermined extent.

The property was inactive from 1912 until 1931 when the Governor Mines Company acquired the mine. The first production by this company was in 1938 when about 200 tons of ore were mined, mostly from the 100- and 400-foot levels of the 400-foot shaft. A cut-and-fill stope method of mining was used. The ore, reported to have averaged $10 per ton in gold (Sampson, 1937, p. 189), was milled at the Governor mill at Acton. In 1940 the mine was again briefly active under the same ownership. Since then it has been inactive and nearly all machinery has been removed.

Rogers and Gentry (Newa, Big Susanna) Mine. (See also Brite, Russell and Myler, and Tuttle leases.) Location: sec. 27, T. 8 N., R. 16 W., S.B.M., in hills of the south side of Antelope Valley, about 1½ miles southeast of Neenach school, about 17 miles east of Gorman. Owner: Leo and Esther Harris, 4542 Lomita Street, Los Angeles, own the property under a homestead patent. One hundred and sixty acres are leased to Newa Mining Corporation, Livingstone Greenwood, president, 3433 West 64th Street, Seattle, Washington; local address: Star Route 1, Box 49A, Lancaster.

The Rogers and Gentry mine has yielded about 5,000 tons of gold-silver ore valued at over $50,000; the bulk of production was made during the period 1935 to 1938. It has since been leased and worked on a minor scale by several companies.

Gold and silver occur in a quartz vein which cuts Jurassic (?) quartz monzonite widely exposed in this area (Wiese, 1950, pp. 28-29). The vein strikes N. 25°-50° W. and dips from vertical to 45° SW. It is as much as 6 feet wide, and can be traced for over a thousand feet

* Gage, Francis, Personal communication, 1952.

southeastward to the Russell and Myler, Brite, and Tuttle leases. The quartz contains free gold, minor amounts of silver, and pyrite. The Rogers and Gentry ore shoot is 75 to 100 feet long, 3 to 6 feet wide; ore shipments have averaged \$40 to \$60 per ton in value (Sampson, 1937, p. 191). The vein is shattered and somewhat oxidized, lying along a fault zone that strikes about N. 40° W. This fault may be related to the northwest-trending San Andreas fault zone which passes about 2½ miles southwest of the mine.

Most old workings have been largely obscured by subsequent operations. Two southeast-trending drifts have been driven on the vein about 30 feet apart vertically. In 1952 the lower drift was 90 feet long and the upper drift was 150 feet long, but the latter was inaccessible because of caving. Both drifts pass beneath a glory hole once 50 feet long, 12 feet wide, and 25 feet deep, but now unrecognizable. A 200-foot shaft sunk from the level of the old adit is now largely filled, rendering inaccessible workings on the 100- and 200-foot levels.

Since 1938 activity at the mine has been intermittent. From 1940 through 1942 the property yielded several thousand dollars worth of gold. In 1945 W. J. Rogers operated the mine briefly. From 1946 to 1950 it was leased to Antelope Mining Corporation, c/o W. B. Stevens, president, 746 North Heliotrope Drive, Los Angeles. Two shipments totalling about 30 tons of concentrates were made during this period. In 1951 Newa Corporation commenced work, producing about 20 tons of concentrates in a mill on the property. In 1952 approximately 100 tons were reported mined as the lower drift was extended. Three men were employed in 1951 and 1952, when about 300 feet of new underground workings were driven.

The mill includes a 6- by 9-inch jaw crusher, bucket elevator, 3-foot Cottrell ball mill in closed circuit with a Dorr-type drag classifier, and a six-cell flotation unit, all run by individual electric motors from a 60 kilowatt diesel-powered generator. The mill was inactive in 1952.

San Gabriel Valley Placers. Location: sec. 3, T. 1 S., R. 10 W., S.B.M. (projected), in the San Gabriel Valley, about one airline mile southwest of Azusa, at the plant of Azusa Rock and Sand Company, Mira Loma at Paramount, Azusa. Ownership: Robert A. Riggs, 1237 South Greenwood Avenue, Montebello, California, treats all sand produced in the Azusa Rock and Sand Company operation on a percentage basis.

This operation was unique in Los Angeles County in 1952 in that placer gold was recovered as a by-product by a large sand and gravel plant. Azusa Rock and Sand Company operates a pit now about half a mile square and from 130 to 140 feet deep in alluvium of the San Gabriel River, and is producing commercial sand, gravel, and crushed rock at a rate of about 450 tons an hour. The material being mined is derived from San Gabriel Canyon, the mouth of which is about 3 miles north of the pit. The alluvium contains various types of granitic rocks and a very low percentage of gold.

About 40 to 60 percent of the total tonnage of material handled by the plant falls in the size range of sand and gravel. This amounts to about 200 tons per hour for 16 hours a day. All of this material passes through the gold-saving equipment and then proceeds to become commercial sand and gravel.

In order not to interfere with the operation of the sand and gravel plant a minimum of gold-recovery equipment is installed, fitted between decks of the plant structure. Construction, repairs, and cleanups are effected on Sundays, when the plant is shut down.

The gold is caught in troughs and riffles as it drops out of the moving stream of water, sand, and gravel. Efficient recovery is hampered by three factors: the fine average size of the gold particles, none of which are larger than grains of wheat; the great speed with which the sand and gravel must pass through the gold-recovery apparatus; and the limited amount of gold-recovery equipment that can be installed.

Concentrates obtained at the plant are removed to Montebello where waste fractions are discarded, magnetite is removed by an electromagnet, and the resultant fraction passed over a concentrating table before being amalgamated.

Riggs has conducted similar operations in several sand and gravel plants since 1929, but has confined his activity to this operation since the present Azusa plant was built in 1946.

In 1953 a similar gold recovery process was in operation in the reactivated Largo plant of Consolidated Rock Products Company, also in San Gabriel Wash.

Lead-Silver-Zinc

Almost all of the lead-silver-zinc ore that has been produced in Los Angeles County has come from deposits on Santa Catalina Island. Occurrences of lead, silver, and zinc minerals on the mainland have been reported (Crawford, 1896, p. 204; Murdoch and Webb, 1948, pp. 149, 274, 278; Preston, 1890a, pp. 203-204; Storms, 1893, pp. 243-245; Tucker, 1921, p. 318; 1927b, pp. 315-317) but these have not been mined systematically, and their production is undetermined but small. Details are summarized in the lead-silver-zinc section of the tabulated index.

Although lead-silver-zinc mineralization on Santa Catalina Island was first reported in 1863 (Tucker, 1927a, p. 33), mining activity was limited largely to the period 1924 to 1927, when three mines and a mill were operated by the Santa Catalina Island Company, owners of the entire island. Sulfide minerals occurring in veins cutting andesite and hornblende schist of the pre-Cretaceous Catalina metamorphic series were treated. A 100-ton flotation plant was erected on the island in 1925 to treat ore from all three mines. Late in 1927 the mines and mill closed because of the pockety nature of the remaining ore and low metal prices. Although the mine openings were mostly open in 1952, there was some flooding at lower levels and the workings were thought to be inaccessible.

The principal mine is the Black Jack, on the northeast slope of Black Jack Mountain. Here a vein, 4 to 25 feet wide, dips 60° NE. in hornblende schist. Galena, sphalerite, pyrite, and traces of chalcopyrite and arsenopyrite occur with quartz, barite, calcite, and a little fluorite.

The mine workings include a three-compartment vertical shaft 535 feet deep with levels at 400 and 500 feet and an adit on the vein. From the adit was sunk a winze with levels at 100, 200, 300, and 400 feet. Underground workings total about 5,000 feet, the longest drift being 390 feet on the 500-foot level. Best values were recovered from an ore

shoot 6 to 12 feet wide developed from the 400-foot level to the surface; this ore shoot was 25 feet wide at the 500-foot level.

The Renton vein deposit, 2 miles southeast of Avalon, consists of five approximately parallel veins from 4 to 18 feet wide, dipping 60° N. and cutting andesite. Ore minerals are sphalerite and galena with some silver. Development work totals about 2,400 feet. The main vein workings are disposed on four levels about 100 feet apart vertically. The longest adit is a 400-foot crosscut at the lowest (No. 4) level with 150-foot drift on the vein. An ore shoot, 130 feet long, averaging 6 feet in width, was developed. A fifth adit comprises 630 feet of drifting on parallel veins.

The Quarry mine, $1\frac{1}{4}$ miles southeast of Avalon, is situated on a vein originally exposed in the face of a rock quarry. The vein dips 70° N., cutting andesite. North-trending shears bound the ore shoot which has a length of 150 feet and an average width of 4 feet. The vein was developed by a 489-foot drift adit on the vein, and a 250-foot winze. Two 350-foot drifts, 85 feet apart vertically, were driven from the winze and on the vein.

Ore from all three mines carried 6 to 12 percent zinc, 1.5 to 3.5 percent lead, and 2 to 3 ounces of silver per ton. It was trammed from the Black Jack and barged from the other two mines to the mill at White's Landing. The mill was unique in that selective flotation was carried out in a salt-water circuit.

Manganese *

Only two localities in Los Angeles County are known to contain manganese in moderate quantities; one is about 6 miles west of Palmdale and the other is in Texas Canyon on the south flank of the Sierra Pelona. The deposits in these localities are of marginal grade and are of minor significance as potential sources of manganese. Manganese oxides, rhodonite, and some spessartite occur in quartzite or in siliceous phases of a quartz-mica schist, believed to be part of the Pelona schist series of pre-Cambrian (?) age. More than 100 tons of manganiferous quartzite were reportedly produced during World War I from the Amargosa group near Palmdale.

Molybdenum

Only four minor occurrences of molybdenum minerals have been noted in Los Angeles County (Murdoch and Webb, 1948, p. 214; 1952, p. 21), none of which is of commercial interest.

Titanium †

Numerous bodies of titaniferous magnetite occur scattered irregularly over an area about 8 miles wide and 20 miles long in the western San Gabriel Mountains. About 36 deposits have been described, some of which contain several million tons of titaniferous magnetite carrying from 5 to 20 percent titanium dioxide (TiO_2). These deposits contain the largest known reserves of titanium in California. Outcrops of the bodies are of various irregular shapes, and from a few feet to several hundred yards in maximum dimension. The bodies are generally enclosed in anorthosite, gabbro, or pyroxenite country rock, but the

* Trask, 1950, pp. 100-103.
† Oakeshott, G. B., 1948, pp. 245-266; Higgs, D. V., 1950.

richest bodies are found in anorthosite in regions where granite pegmatite, aplite, and lamprophyre dikes are most abundant (Oakeshott, 1948, p. 253). Some irregular bodies are in gradational contact with the country rock and others are elongated or dike-like with more sharply defined boundaries. Insufficient exploration work has been done to determine the attitude of more than one or two of the bodies. Emplacement of the bodies is related to late igneous processes connected with the intrusion of the gabbro and anorthosite (Oakeshott, 1950c). In many cases ore minerals are localized along faulted or fractured zones. Titaniferous magnetite is abundantly present as an accessory mineral throughout much of the country rock in this region.

Sands derived from weathering of rocks of the region have accumulated in stream courses in Sand and Pacoima Canyons to form substantial tonnages of titaniferous magnetite concentrates. Beach sands between Redondo Beach and Malaga Cove include concentrations of titaniferous magnetite transported from the San Gabriel Mountains to the ocean by the Los Angeles River, which debouched near Playa del Rey in Recent time.

Titaniferous magnetite is an intergrowth of the minerals ilmenite ($FeO \cdot TiO_2$) and magnetite ($FeO \cdot Fe_2O_3$), which are similar mineralogically. In the San Gabriel Mountains, ilmenite and magnetite are intergrown in such fine grains that a complete mechanical separation of the two minerals by magnetic or other means is extremely difficult. Extraction of titanium and iron ore on an experimental basis from such a mixture has been achieved by smelting in an electric furnace. Three important factors operating against the construction of an electric furnace in Los Angeles County to treat titaniferous magnetite are the large capital investment necessary, high cost of electric power, and the low grade of known titanium reserves.

Of a total of about 14,000 tons of titaniferous magnetite produced in Los Angeles County, about 10,000 tons was produced in 1927-28 from the Iron Blossom deposit. About 2,000 tons was produced in 1947-52 by the Ferro-Titan Company as a by-product in a sand and gravel plant in the Big Tujunga Wash. A small tonnage was produced from placer deposits in Sand Canyon and south of Redondo Beach. Strong deterrents to the mining of the low grade titaniferous magnetite in this region are the lack of suitable treatment processes to make the ores commercial, the irregular size, tenor, and distribution of the deposits, the relative inaccessibility of the deposits, and the large sources of low-cost ore from Travancore, Starke, Tabawas, and Allard Lake.

The first recorded effort to utilize the titaniferous magnetite of the region was in 1906 at Russ Siding in Soledad Canyon where an oil furnace was built in a futile effort to produce iron.

The largest operation was at the Iron Blossom mine on the ridge between Pole and Bear Canyons, 2.4 miles southeast of Lang. In 1927-28, the Mineral Increment Company produced 10,013 tons of ore and shipped it to El Segundo for the manufacture of paint base. Competition from less expensive foreign materials caused the operation to close down.

Eighty-three claims are held by associates of the Beam Smelter Company in an area withdrawn from mineral entry between Iron Moun-

tain, Mount Gleason, and Mill Creek. Relatively high grade ore is reported from the deposits in this group.* Pilot-plant tests have been made on the ore, but no mining has been done on these claims.

Extensive prospecting by the Pigment Division of the E. I. du Pont de Nemours Company began about 1927 and continued until 1938. Magnetometer surveys were carried out over a large area including Sand Canyon, upper Pacoima Canyon, and Mill Creek. All claims of the company were abandoned prior to 1952.

Since 1944, production of titaniferous magnetite has come mainly from placer deposits in Big Tujunga Wash, from the Live Oak property in lower Sand Canyon, and from beach sands at Redondo Beach.

In 1952, production of titaniferous magnetite was confined to the plant operated by Walter Johnstone and Thomas J. Wright at 330 Second Street, Hermosa Beach. The source of raw material for this plant is the stockpile of titaniferous magnetite concentrates mined and screened at Redondo Beach in 1926 by Burdick Minerals Corporation (see tabulated index). The stockpiled sand is separated on a concentrating table, dried, and sacked for sale as granules for manufactured roofing paper. About 50 tons of titaniferous magnetite were produced monthly and a minor amount of heavy sand concentrates was sold for use as a blasting sand. Two men are employed at the plant.

Tungsten

Scheelite occurrences have been noted in the San Gabriel Mountains near Sierra Madre (Aubury, 1906, p. 372) and near Monrovia,** but no production is recorded.

Several plants in the Los Angeles area have milled tungsten ores or processed tungsten concentrates. Tungsten treatment plants active in 1952-53 included the Sun Valley Tungsten Company and Tungsten Processing Company custom mills, Pacific Metallurgical Products Company, and Western Metallurgical Company chemical processing plants, and the Gage ore-testing plant. (See tungsten section in tabulated index.)

Uranium

Although small amounts of carnotite have been found near Lancaster, in Antelope Valley,† no production of uranium ore has been reported in Los Angeles County.

Nonmetallic Minerals

Asbestos

About 50 tons of short-fiber chrysotile asbestos was mined in 1929 from the Fiber Queen mine in the San Gabriel Mountains north of San Fernando. The asbestos is in a shear zone in a chloritized metaserpentine. No other occurrences of asbestos have been reported.

Barite

Barite has been found (Murdoch and Webb, 1948, p. 65) at several places in Los Angeles County. Only one deposit, on the west fork of San Dimas Canyon, is reported to have been mined, yielding a "small tonnage" (Merrill, 1919, p. 480) in 1915.

* Beam, L. M., Personal communication, 1953.
** Dilworth, H. J., Personal communication, 1953.
† Sampson, R. J., Personal communication, 1952.

Barite occurs in the gangue of the Kelsey mine in San Gabriel Canyon, in the Black Jack and Renton mines on Santa Catalina Island, and in the old Felix fluorite property north of Azusa. Small crystals and aggregates of barite exist in veins in the sea cliffs of the Palos Verdes Hills (Schwartz, 1943, p. 8).

Bituminous Shale

Limited showings of bituminous shale were reported $1\frac{1}{2}$ miles southwest of Newhall (Preston, 1890a, p. 204) apparently in the upper Miocene Modelo formation, and also in Modelo strata in the Santa Monica Mountains west of Santa Monica (Hoots, 1931, pp. 109-110). Tests of the Newhall material prior to 1889 indicated 72 percent of carbonaceous material and 25 percent ash. Bureau of Mines distillation tests of the Santa Monica Mountains material indicated oil yield of 3.1 to 18 gallons per ton (Hoots, 1931, p. 110). Neither showing has been of commercial importance.

Borates

Occurrences of boron minerals have been noted in Los Angeles County in Oligocene (?) rocks of the Vasquez series. Only one deposit, the Lang, proved extensive enough to be mined.

Lang (Sterling) Mine. Location: secs. 27, 28, 29, 31, and 32, T. 5 N., R. 14 W., S. B. M., in Tick Canyon, about $1\frac{1}{4}$ airline miles east of the Mint Canyon highway, about $3\frac{1}{2}$ airline miles north of Lang. Ownership: Pacific Coast Borax Company Division of Borax Consolidated, Ltd., 630 Shatto Place, Los Angeles, California owns many patented

FIGURE 5. View northwest across dump of Lang borax mine in Tick Canyon. Light-colored beds in middle distance are borate-bearing sediments of Oligocene (?) Vasquez formation. Abandoned mine workings are hidden behind the hill in the center of the picture.

claims covering an area about $1\frac{3}{4}$ miles in length and about 2,000 feet in width.

The Lang mine, the only source of borates in Los Angeles County, was active from 1908 to 1922 when its mineable calcium borate bodies were exhausted.

The borate minerals occur in shale beds in the nonmarine Vasquez series of Oligocene (?) age.* The Vasquez series is composed principally of arkose (in part tuffaceous), basalt, and conglomerate with subordinate limestone and shale members. The Vasquez series in the vicinity of the mine has been deformed into northeast-trending folds modified by many cross-faults and longitudinal faults. The interlayering of competent volcanic rocks with incompetent sedimentary sequences has contributed to the structural complexity of the area. The dominantly sedimentary nonmarine Miocene Tick Canyon and Mint Canyon formations unconformably overlap the distorted Vasquez beds north and south of the mine area.

Borate minerals present include colemanite ($Ca_2B_6O_{11} \cdot 5H_2O$), the principal ore mineral, in by far the greatest abundance; howlite ($H_5Ca_2B_5SiO_{14}$), which occurs in cauliflower-like masses much prized by mineral collectors; probertite ($NaCaB_5O_9 \cdot 5H_2O$); and ulexite ($NaCaB_5O_9 \cdot 8H_2O$). A colemanite-bearing bed as much as 30 feet thick and about 1,000 feet long is enclosed in and intermixed with shale. This bed strikes a little north of east and dips about 70° S. on the north flank of a syncline plunging gently southwest. Thinner colemanite layers and several thin howlite-bearing strata are also present but were not mined. Borate-bearing layers of sub-commercial grade have been prospected in many places over the area of the company holdings, which extend for nearly 2 miles along the northeast strike of the principal colemanite-bearing bed.

The origin of the deposits is discussed by Gale (1914, pp. 4-5) who quotes Eakle (1911) saying "It seems probable that the original site of the deposit was a marsh containing marl and calc tufa with mud and considerable organic growth, and that later waters charged with boracic acid flowed into the basin and converted the carbonate of lime into the borate. . . The origin of the boric acid is presumably volcanic." The strongly monomineralic character of the deposit and lack of mixed alkali salts indicate that it was not formed by evaporation of desert lake waters.

The colemanite was mined through two vertical shafts, each 350 feet deep, from workings on the 100- 200- and 300-foot levels and from numerous auxiliary openings. The deposit was mined along a strike distance of 800 to 1,000 feet, one segment about 600 feet long being mined on all three levels. Mining methods included the use of square-set stopes in some places and shrinkage stopes in others. The shrinkage stopes were about 70 feet long, 60 feet high, and 20 feet wide above the ore chutes. The square-set stopes were about 40 to 60 feet wide, 70 feet long, and 60 feet high. Pumping was required to keep the lower levels free of water.

Although many details of the history of operation of the deposit have been lost in the passing of time, the following general account has been

* Geologic description largely summarized from data supplied by R. H. Jahns and others, Dept. of Geological Sciences, California Inst. of Technology, 1952.

reconstructed from unpublished records and from conversation with men acquainted with the deposit.*

In November 1907 colemanite was discovered on the property, but production did not commence until 1908. The deposit was acquired by the Sterling Borax Company, a consolidation of borax interests including Stauffer Chemical Company's Frazier Borate Mining Company, American Borax Company (boric acid works at Daggett), Brighton Chemical Company (refinery in Pennsylvania), and Thomas Thorkildsen and Company (refinery in Chicago).

During the earliest operations of the mine the colemanite was sacked for shipment, but four oil-burning calcining furnaces were later installed. Two were wedge furnaces with a capacity of about 40 tons each per 24 hours; the other two were horizontal furnaces 50 feet long with a capacity of 60 tons each. After the water of crystallization was driven out by roasting, the bulk of the admixed shale impurity was removed by means of an air current passing through a cone screen. A refined ore containing 48 to 50 percent boric oxide (B_2O_3) was produced in this way and shipped via a standard-gauge railroad built especially from the mine to Lang Siding of the Southern Pacific Railroad. The bulk of the refined ore was shipped to the several eastern refineries of the company for conversion to commercial borax.

About 80 men were employed at the mine. The maximum daily production was about 400 tons, and an output of nearly $500,000 worth of calcium borate was credited to the mine for the year 1914 (Tucker, 1927b, pp. 318-319). During World War I mine production was limited by a shortage of railroad cars available for shipping the ore. Unpublished records of the California Division of Mines indicate that total production during the 16-year life of the mine was about 100,000 tons of ore valued at about 3 million dollars. The mine yielded a substantial share of the colemanite mined in the United States from 1908 to 1920.

During the latter portion of the period 1911-18, during which the deposit was nearly mined out, the Pacific Coast Borax Company entered into a sales agreement with the Sterling Borax Company, but did not own or operate the property. Faced with an ever-declining price for borax and, as the mine grew deeper, with rising mining costs, the property was sold to Pacfic Coast Borax Company in 1921. The new owners conducted a scavenging operation in which nearly all remaining colemanite was removed. The depletion of the known reserves of colemanite led to the final closing of the Lang mine in 1922, and dismantling of the plant in 1926. The development of a rich deposit of the sodium borate, kernite, at Boron in 1926 marked the end of the extensive mining of colemanite in the state. The Lang mine workings are now caved to an unknown extent and are flooded below the 150-foot level. The thin seams of colemanite remaining at the property are now sub-commercial and the siliceous borate, howlite, is not marketable.

* Gower, Harrison, chief geologist for Pacific Coast Borax Company, Personal communication, 1952; Ross, Norman, master mechanic of Boron plant, Pacific Coast Borax Company, Personal communication, 1952; and Ver Planck, W. E., Jr., assistant mining geologist, California Division of Mines, Personal communication, 1954.

Clay Products *

Clay has been produced in large quantities in Los Angeles County for many years, its use almost entirely limited to the brick, tile, and sewer pipe industry. Clay used for these purposes is classified as "miscellaneous" or "common." Tremendous industrial and population expansion in the county over the past 50 years, and particularly the past decade, has maintained a high demand for common clay. In 1951 Los Angeles County, leading the 23 California counties that reported production of common clay, yielded 466,820 tons valued at $381,148. An ample supply of common clay and shale exists within and close to the Los Angeles metropolitan area and numerous deposits have been mined. No refractory clay, ball clay, or china clay is produced in the county, although an occurrence of high-grade clay has been reported on Malibu Ranch, north of Santa Monica (Dietrich, 1928, p. 93). These higher quality clays are brought into the county for use in several plants which produce various types of ceramic products, and for use as additives in the manufacture of sewer pipe. Clay is brought in largely from Riverside, Orange, and San Diego Counties in California, and from Florida, Kentucky, and Tennessee.

In the production of heavy clay products, such as brick and tile, proximity of the raw material to the plant is a more important factor than quality of the clay. Clay for sewer-pipe has more exacting specifications, and locally mined common clay is usually added in minor proportions to refractory fire clay from out-of-county sources.

Common clay is a mixture of various proportions of clay minerals, weathered clastic mineral fragments, sand, soil of varying organic content, and a few pebbles. The clay mineral most commonly present is illite, a hydrous potash-bearing silicate intermediate between muscovite and montmorillonite type clay in composition and structure. An appreciable percentage of sand grains and other nonclay mineral constituents are desirable in the clay to reduce shrinkage and lower the fusion point. Limestone fragments are harmful, except where very finely ground, because they calcine during firing and later swell or react with the mortar.

Other deleterious substances include various soluble salts brought to the surface of the product during drying or firing. These salts appear as white efflorescences which discolor the surface of the product. These efflorescences are most commonly sulfates of potassium, sodium, calcium, magnesium, and aluminum, but other salts such as chlorides and carbonates also occur. To combat this problem, which occurs at several yards, barium carbonate is added to the raw mixture in minute percentages to form an insoluble sulfate which remains permanently within the brick.

The color of the raw clay ranges from very dark brown to very light brown or buff. The texture and general appearance differ from place to place according to the proportions of clay and other constituents and the character of the bedding. The fired products also vary notably in unit weight and in color, being various shades of red.

Clay-rich river and flood-plain alluvium, the principal source of common clay in Los Angeles County, is abundant in many areas. Clay

* Aubury, 1906, pp. 213-217, 243-249; Boalich, and others, 1920, pp. 49-63; Crawford, 1894, pp. 381-382; 1896, pp. 614-615; Dietrich, 1928, pp. 92-123; Kirkendale, 1948; Merrill, 1919, pp. 488-499.

pits are or have been active in various parts of the county, including Santa Monica, Elysian Park, Boyle Heights, the Torrance-Gardena area, Castaic, Los Nietos, Pomona, and Reseda.

In most of these areas the deposits are very similar, being the uppermost material in alluvial flood plains. In several places, such as Higgins Brick and Tile Company's Ramona yard, and the yards of Davidson Brick Company and Pomona Brick Company, older, uplifted alluvial deposits are mined. The Castaic Brick Company, the only operator now using shale in brick manufacture, quarries upper Miocene Modelo (Castaic) siltstone and shale. In the Elysian Park area bedded deposits of shale of the upper Miocene Puente-Modelo formation were used for brick. Where the clay is in horizontal flood plain deposits, it commonly has a small percentage of admixed sand, and in many pits, the bottom of the clay deposit is marked by a strong increase in the proportion of sand.

Brick and tile always have been popular building materials in the Los Angeles area and during periods of great building activity brick, tile and sewer pipe have been produced in large quantities. In 1928 fifty-six manufacturing plants were active (Dietrich, 1928, pp. 92-123) utilizing clay from at least 25 pits within the county and producing almost every conceivable type of clay product. In the depression years of the early 1930s many of the plants and pits closed; but since 1940, with the tremendous expansion of industry and increase in population in the county, the industry has again prospered. At present about 20 brick tile, or sewer-pipe yards are active in the county, all mining clay at their own yards. The four producers of sewer-pipe also bring some clay into the county. Although nearly all the currently operating clay pits occupy or adjoin sites active 25 years ago, many of the pits closed during the 1930s are no longer available to mining. In part this is caused by depletion of the recoverable clay, but in greater part it is caused by conversion of those areas into residential and industrial zones. Property values have become too high for the land to be used for clay pits, and zoning restrictions exclude commercial activity from residence areas. Several of the old pits in the Santa Monica area were mined to the property lines and to the bottom depth of the clay and have been or are now being used for dump sites.

Most of the brick marketed in recent years has been used in the construction of large buildings, such as supermarkets and factories, as well as for chimneys, porches, and walls of dwellings. Investigations have shown that well-built brick structures, erected in accordance with specifications of the building code, survive earthquakes as well as do properly built structures made of other materials (California Div. Mines, 1952). The use of brick in buildings has been recently stimulated by the increased popularity of commercial or oversize brick which may be laid appreciably faster than standard brick, thus reducing labor costs. Whereas standard brick measures about $2\frac{1}{2}$ by 4 by 8 inches, the oversize brick measures about $3\frac{1}{4}$ by $3\frac{1}{2}$ by $9\frac{3}{4}$ inches. One firm produces modular brick, 3 by $3\frac{3}{8}$ by $11\frac{3}{8}$ inches, which has measurements in multiples of 4 inches when laid, thereby simplifying calculations for designs. Differences in shrinkage cause these measurements to vary slightly.

Mechanization of the heavy ceramic industry is an important factor in its present prosperity. From mining the clay to handling the fired product, machinery has made nearly every operation more efficient. Mining is done by large shovels, bulldozers, and carryalls; belt conveyors speed transportation of material; disintegrators supplement the dry-pan grinders; single automatic machines combine pug mill, auger, de-airing, extruding die and cutter into one synchronized operation; continuous extrusion processes are adaptable to all but the largest products; belt, pallet, and roller track conveyors speed the shaped products; automatic-grip brick lift forks handle bricks in large blocks, green as well as fired; glaze is applied automatically to interiors of sewer pipes; controlled drying rooms insure correct preparation of products for firing; continuous-motion kilns speed the firing of sewer pipe. These new techniques and machines are not in universal use but are employed with success by many plants.

Similar mining methods are used in all pits in Los Angeles County, in sidehill quarries as well as pits on horizontal land. Blasting is unnecessary, the soft material being removed by heavy machinery, principally bulldozers and tractor-pulled carryalls. Except for use in roof-tile plants, clay is mined dry or nearly so to permit it to be dry-ground. This usually limits mining to dry months unless dry-storage stockpiles are maintained. The clay is transported from the pit to the plant, rarely more than a quarter of a mile, by truck, belt conveyor, carryall, or by a combination of these.

Brick Plants. In the manufacture of brick by the stiff-mud process, the raw clay is ground to $\frac{1}{4}$ to $\frac{1}{8}$ inch maximum screen size, usually in a dry-pan grinder. Two of the plants in Los Angeles County use a disintegrator before the dry-pan and send only oversize from the initial screen to the grinder, thereby increasing the grinding rate. From the dry-pan screen the dry clay enters the pug mill where it is wet and kneaded (pugged) to desired consistency. An auger then forces the moist clay into a de-airing chamber where it is compressed and the air is removed under a slight vacuum. In the stiff-mud or wire-cut process the clay is then forced through a metal extruding head, which shapes it into a continuous bar of rectangular cross section corresponding to the two longer dimensions of the brick. As this slightly plastic bar is continuously extruded, a set of wires, from 12 to 23 in number, on a synchronized revolving framework, cuts the bar into the shape of bricks. One of these machines can produce as many as 20,000 bricks an hour. From a moving belt, the new bricks are picked (hacked) by hand and stacked for removal to a drying yard or tunnel drier. If bricks are dried in open air, plant operations are restricted to dry months of the year, unless enough brick are dried in the dry season to carry the plant through the winter. Use of tunnel driers enables continuous operation of the plant without regard to weather conditions.

Decorative ruffle brick is made by placing small points inside the extruding head, creating a fluted effect in the side of the stiff brick being extruded. By the use of different extruder heads various brick products such as clay block, hollow tile, angle brick, or pier brick may be produced using essentially the same process.

Clay Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	HOLDING	GEOLOGICAL DATA	MINING DATA	
	Sec.	T.	R.	B&M			Nature of deposit	Equipment, haulage	Approximate size of excavation: Length Width Depth
Angulo Tile Co. 19044 Kittredge St., Reseda, P.O. Box 97, Reseda	10	1N	16W	SB proj.	Continuously active since opened about 1922.	18 acres	Valley floor alluvium; dark clay with sandy layers, no overburden, bottoms at 10-12 ft. depth in gravel.	Gasoline shovel loads trucks for ¼-mile haul to plant.	200 ft. × 200 ft. × 8-10 ft. max.
Atkinson Brick Co., 13633 S. Central Ave., Los Angeles 59	16	3S	13W	SB proj.	Continuously active since 1939.	34 acres	Valley floor alluvium, silty brown clay, bottoms at about 20 ft. on massive sand layer.	Electric shovel, diesel skip loader, truck hauls 200 yds. to plant.	100 yds. × 350 yds. × 18-22 ft. max.
Atlas Sewer Pipe Co. 10009 S. Painter Ave. Whittier	32	2S	11W	SB proj.	Produced floor, roof tile prior World War II (Taylor); inactive during war; Atlas Co. active since 1946.	9 acres	Alluvial brown, flat-lying, red-burning sandy clay, no overburden. (Mix with Riverside Co. fire clay.) Bottoms in sand at 38 ft. depth.	Bulldozer stores sufficient clay for 2 months operation in one day, pushing clay 120 yds. to plant.	200 ft. × 300 ft. × 20 ft. max.
Builders Brick Co. 17620 S. Western Ave., Gardena	35	3S	14W	SB proj.	Old pit active 1927-28, to 1949; present pit active since 1949.	Abandoned pit: 10 acres active pit: 4 acres.	Gray common alluvial clay, red-firing. Bottoms in sandy material at 40 ft. depth.	1-yd. diesel shovel loads trucks for 0.3 mi. haul across Western Ave. to plant.	150 ft. × 250 ft. × 40 ft. max.
Castaic Brick Co., J. W. Aregood, Castaic	13	5N	17W	SB	Active prior 1949 by Southern Calif. Brick Co., Castaic Co. active since 1949.	Several acres	Upper Miocene Modelo fine-grained siltstone and shale, red-burning: sidehill open cut.	Power shovel.	Face several hundred ft. wide; over 100 ft. high.
Davidson Brick Co., 4701 E. Floral Dr., Los Angeles 59	29,32	1S	12W	SB	Active prior 1920 as Metallic Brick Co., Davidson Brick Co. since early 1920s.	About 100 acres	Upper Miocene Puente (also called Monterey) reddish and bluish shales. Open cut mining along hillside.	Tractors and carryalls haul about 200 yds. to hoppers at plant.	About 20 acres; maximum height of face 150 ft.

products.
active in 1952.

PROCESSING PLANT				REMARKS
Equipment, process, firing	Products	Approximate capacity	Number of employees	
Wet clay from pit, lumps dedestroyed in roll crusher (no screens or pugging), direct to tile machine, belts to drying sheds, 6 open, up-draft kilns.	Mission tile, clay shingles.	2 million tile in 1952	10-20	Seasonal operation, dry months only, because of transportation difficulties. $BaCO_3$ added to prevent efflorescence. About 10 minutes elapse between clay in the pit and tile in the dry-sheds.
Stiff mud process; disintegrator, screen, dry-pan crusher, pugmill, combination de-airing-extrusion machine, wire cutter, belt, fork lift to field kilns.	Common brick, ruffle brick, Roman brick, 6 × 4 × 12-in. clay blocks.	140,000 bricks per day	45 total	Mine clay only in dry months. Complete mechanization of process; first company in this area to use brick fork lift on green brick while setting kilns.
Dry-pan crushing, screen, pugmill pipe-extruding machine; racks to dry house (17 hrs.) two down-draft gas-oil kilns (37 hrs.).	Sewer pipe, 4-in. size only, and various fittings.	35-40 tons per hr.	23 total	Blend local clay with fire clay from Corona district.
Stiff mud process. Roll crusher, screen, pug-mill, auger, de-airing chamber, wire cutter. Gas-fired field kilns.	Common brick	120,000 brick per day	50	Closed during rainy months (end of September to March or April).
Field kilns	Common brick	75,000 brick per day	--	Plant expanded from 30,000 to 75,000 bricks daily capacity in 1953.
Stiff-mud process. Roll crusher, vibrating screens, combined pug-mill and auger machine. Tunnel driers, field kilns.	Common brick, standard size and oversize (3¼″ × 3¼″ × 10″); modular brick 3″ × 3⅝″ × 11⅝″); modular structural blocks, 6″ and 8″ deep; angle brick; pier brick.	Large, but varies.	40-110, depending on season.	Tunnel drying facilities enable year-round operation.

Clay Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	HOLDING	GEOLOGICAL DATA	MINING DATA	
	Sec.	T.	R.	B&M			Nature of deposit	Equipment, haulage	Approximate size of excavation Length Width Depth
Higgins Brick & Tile Co. (Gardena plant) 2217 W. 174th St., Torrance, P.O. Box 1125, Station A, Gardena	35	3S	14W	SB proj.	Active since 1927 by Higgins Co.	20 acres	Flat-lying, brown silty alluvium, red-firing. Water at 40-ft. depth; sea shells at 60-ft. depth.	Pneumatic-tired Caterpillar 60 carry-all tractor-scraper loads a 20-in. belt conveyor through trap. Conveyor hauls about 100 yds. to plant.	250 yds. × 1000 yds. × 40 ft. av. max.
Higgins Brick & Tile Co. (Ramona yard) 4700 Ramona Blvd., Monterey Park	29	1S	12W	SB	Active mid-1930s to 1947 (Tapper Brick Co.) Higgins active since 1947.	About 40 acres	Bedded blue-gray clay, silt, shale. Sidehill open cut.	Caterpillar D6 plow, disc; haul in caterpillar carryall about 50 yds. to hopper loading conveyor belt for 15-ft. haul to mill.	300 yds. × 500 yds. × 20 ft. (total 10 acres) max.
Higgins Brick & Tile Co. (Santa Monica yard) 2600 Colorado St., Santa Monica	5	2S	15W	SB proj.	Opened 1922 by Western Brick Co., later known as Pacific Brick Co. Active since 1946 by Higgins.	23 acres	Flat-lying sandy brown clay, 1-2 ft. of overburden.	Caterpillar carryall loads conveyor belt for 300-ft. haul to plant.	300 yds. × 400 yds. × 50 ft. (11-12 acres) max.
Lynn Brick Co., Bert M. Lynn, P.O. Box B, Harbor City (Plant 25901 S. Normandie Ave., Harbor City)	36	4S	14W	SB proj.	Active 1924-28. Long Beach Brick Co. Operated since 1946 by Lynn Brick Co.	4.57 acres	Alluvial common brown-red sandy clay, no overburden, bottoms in sand at 50-60 ft. depth.	Gasoline shovel loads truck for 100-200 yd. haul to plant.	100 yds. × 150 yds. × 50-60 ft. av.
Pacific Clay Products Co. (Plant No. 6, Los Nietos) 9500 S. Norwalk Blvd., Los Nietos	31	2S	11W	SB proj.	East pit active since 1911 (Pacific Sewer Pipe Co.) Wolfskill pit active since 1942.	24 acres	Brown-tan adobe alluvial clay, bearing some sand.	⅜-yd. Bay City gasoline shovel loads 6-yd. dump trucks for haul about 1000 ft. to storage pile at plant, where bulldozer spreads and crushes it.	(a) 300 ft. × 500 ft. × 12 ft. (b) 400 ft. × 600 ft. × 12 ft.

products.—Continued.
active in 1952.

PROCESSING PLANT				REMARKS
Equipment, process, firing	Products	Approximate capacity	Number of employees	
Stiff-mud. Dry-pan crusher, vibrating screens, combined pug-mill, de-airing chamber, and auger extruding machine. Sun dried, field kilns.	Common brick, building tile.	100,000 brick per day 7-8 mo. per year.	50 total	Active during dry months only.
Stiff mud process. Dry-pan crusher screen, feeder to pug-mill, extruded to wire cutter, to pallets for sun drying (3 wks.); field kilns (10 days).	Common brick, commercial brick.	80,000 common or 60,000 commercial brick per day.	25(dry months) 8-10 (wet months)	Active during dry months only, principally because of difficulty drying and firing brick. Plant expending about 25% in 1953. $BaCO_3$ added to control white efflorescence.
Stiff-mud process. Dry-pan grinder, pug-mill, auger-extruding machine. Sun drying; field kilns.	Common brick, oversize brick.	100,000 brick per day.	30	Production in dry season only.
Stiff-mud process. Dry-pan grinder, screens, hopper, combination pug-mill and de-airing auger machine, wire cutter. Hot air drier, field kilns.	Common brick.	35,000 brick per day.	15	Active in dry season only. Since pit at plant is nearly depleted clay is also mined in other pits nearby.
Roll and dry-pan crushers, screened and blended, combined pug-mill and auger de-airing extruding machine; fully automatic continuous extruding machines for 4-8 in. pipe. Drying rooms, tunnel kiln and 40 periodic down-draft kilns.	Sewer pipe (4 to 42 in.) flue lining, chimney pipe, drain tile, quarry tile, face brick, telephone conduit, power duct, fitting shapes.	--	--	Largest sewer pipe plant in the west. Local clay is blended with Riverside County clays.

Clay Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	HOLDING	GEOLOGICAL DATA	MINING DATA	
	Sec.	T.	R.	B&M			Nature of deposit	Equipment, haulage	Approximate size of excavation: Length Width Depth
Pomona Brick Co., P.O. Box 239, Pomona (plant at 9th and Buena Vista, Pomona)	25,36	1S	9W	SB proj.	Active "over 60 years" until 1943 in old pit. Present (south) pit open since 1944	Old: 8 acres new: 11 acres	Old pit: 5 ft. of blue clay under 18 ft. of overburden. New pit: red common brick clay 6-15 ft. deep on slope overlying decomposed granite.	Gasoline shovel loads trucks for ½-mile haul to plant.	700 ft. × 700 ft. × 9 ft. av. (old pit covvered about four blocks, now nearly filled).
San Valle Tile Kilns, 6601 Wilbur, Reseda	10	1N	16W	SB proj.	Continuously active since about 1927.	15 acres (20-acre reserve)	Valley floor alluvium, adobe clay with streaks of silt. Below 8-ft. depth lime is detrimental.	Gasoline shovel loads trucks for ¼-mile haul to plant.	50 ft. × 500 ft. × 8 ft. max.
Simons Brick Co., R.F.D., Montebello (Plant at Vail Ave. at Rivera Rd., Montebello)	15,16	2S	12W	SB proj.	This plant active from about 1924 to late 1952.	300 acres (three main pits in a line 1 mile long)	Flat-lying brown silty alluvial clay with admixed sand. Bottomed in sand at about 18-ft. depth.	Steam and diesel shovels load clay dumper cars on narrow gage railroad for ¼-¾-mile haul to plant.	150 yds. × 1 mi. × 8-15 ft. av. (three irregular pits each about 500 ft. × 1500 ft. in zone 1 mile long, 150 yds. wide).
Valley Brick & Supply Co., 6151 Kester Ave., Van Nuys	9	1N	15W	SB proj.	Started 1922 (Owens Brick Co.); 1927 (California Brick & Tile Co.); present company active since 1943.	27 acres (16 acres of clay)	Valley floor alluvium of light yellow-buff sandy clay. No gravel; no overburden.	Two gasoline shovels, dragline, load trucks for ¼-mile haul to plant. (Slackline cable dragline formerly used above water level.)	600 ft. × 600 ft. × 33 ft. (12 acres) max.
Western Ave. Brick Co. 17799 S. Western Ave., Gardena	35	3S	14W	SB proj.	Active since prior to 1930; (Star Brick & Tile Co., then Southwest Brick Co.) Present operators since 1950.	16 acres	Gray sandy alluvial clay under 2-3 ft. of soil overburden.	Diesel shovel loads trucks for ⅛-¼ mile haul to plant.	200 yds. × 650 yds. × 35 ft. av.

products.—Continued.
active in 1952.

PROCESSING PLANT				REMARKS
Equipment, process, firing	Products	Approximate capacity	Number of employees	
Soft mud process prior 1943. Now stiff mud process: J. C. Steele disintegrator, screen, dry pan crusher, bin. J. C. Steele No. 54 combined brick machine. Sun drying; field kilns.	Common brick. Commercial Rancho brick.	35,000 bricks per day.	20 total	Operate in dry months, except for emergency demands.
Wet clay from pit goes through rolls to break lumps, to continuous-extrusion tile machine, to driers, seven up-draft kilns.	Mission tile. (Also pottery from clay purchased elsewhere).	50 squares (10,000 tile) per day.	28-32	Stored clay permits year-round operation. Dispensing with grinding and pugging speeds production greatly.
Soft-mud process. Crush in dry-pan grinder, mix in pug-mill, press into six-brick wooden molds, sun dry (6-12 days), fire in field kilns.	Common brick in several sizes including oversize or commercial.	57,600 brick per day (1923-28); 14,400 per day in 1952	300 (1923-28) 40 (1952)	Last of soft-mud process plants; closed in late 1952 after 68 years activity in several areas. Property sold for industrial sites.
Stiff-mud process. Grizzly, disintegrator, screen, oversize to 9-ft. dry-pan grinder, pug-mill, de-airing, auger extruding machine, wire cutter. Sun-dry (65%), tunnel dry (35%); field kilns.	Common brick (5 sizes).	100,000 brick per day.	54	Operate during dry months only, about March-November, because raw clay must be dry to disintegrate properly.
Stiff-mud process. Dry-pan crusher, screen, pug-mill, auger, wire cutter. Sun-drying; field kilns.	Common brick.	60,000 brick per day.	33 total	Operate only during dry months.

Figures given for the capacity of clay products plants are of general significance only, because of the following variable factors inherent in the industry: (1) length of work-day; of work-week; of production year (dry months); (2) variation of capacity with different products in production; with down-time for changing dies, etc.; (3) impossibility of maintaining continuously the rated capacity of machinery. The limiting factor of plant output is usually either effective capacity of machinery in use, storage space for pre-firing drying, or capacity of kilns.

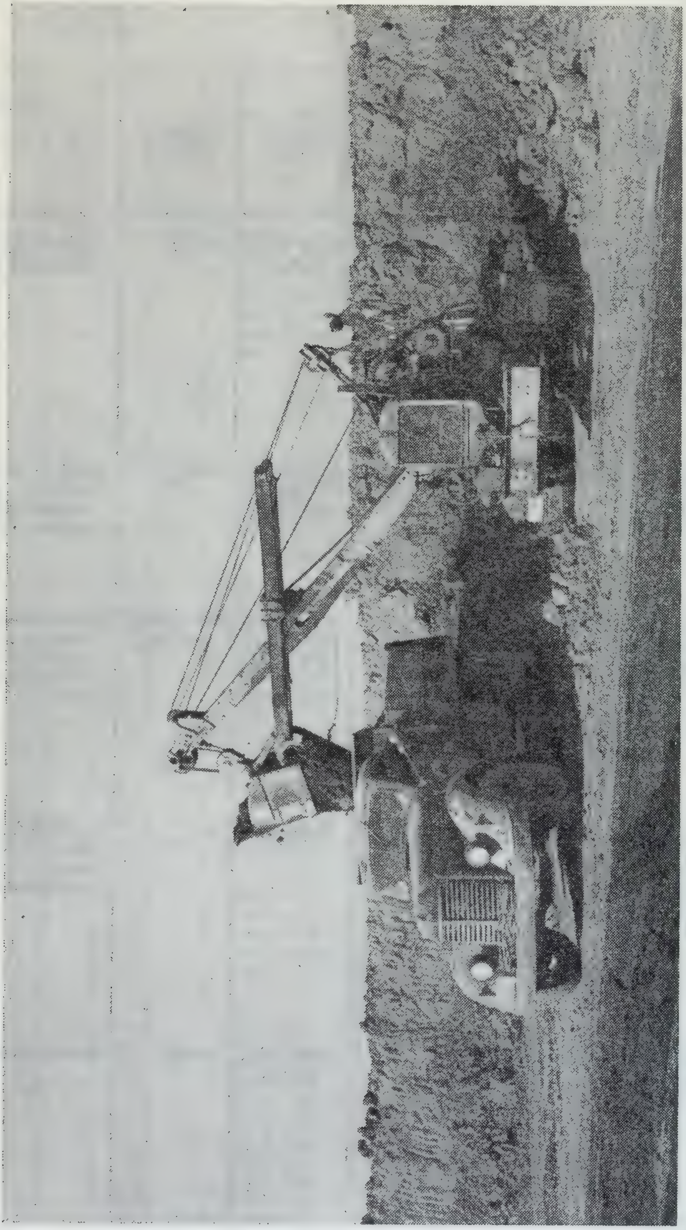

Figure 6. Loading common clay at Wolfskill pit of Pacific Clay Products Company, Los Nietos. *Photo courtesy Pacific Clay Products Company.*

After they are dried enough to be handled the bricks are removed to field kilns for further drying and firing.

The field kiln is a large mass of loosely spaced, carefully placed green bricks, commonly 100 to 150 feet long, 35 to 50 feet wide, and 12 to 20 feet high. Across the width in the lower part of the structure are carefully laid tunnels about 4 feet high, 2 feet wide at the bottom with a corbeled roof (tapering together upwards) and about 5 feet apart. At each end of every tunnel is placed the nozzle of the gas or oil pipe for firing the kiln. The kiln is left, covered if necessary, for 1 to 3 weeks—longer in wet weather—to dry in the open air. An insulating wall 2 or 3 feet thick of old brick set in raw clay is built around the kiln just before firing. The kiln is fired for 10 to 20 days, depending on moisture in the air, the brick being ready for use after cooling.

The outmoded soft-mud or sand-mold process departs from the stiff-mud process mainly in detail of formation of the brick. In the sand-mold process a moister clay mix is used, and poured into wooden molds previously dusted with sand to prevent clay from sticking. After drying for 6 to 12 days, the bricks are removed from the molds, set into field kilns, further dried and fired, as described above. Compared with the stiff-mud process, this process requires more drying time, more handling with attendant increase in labor costs, more equipment, and more space, and produces a less compact, weaker brick which suffers greater shrinkage. The last plant to make sand-mold brick, the Simons Brick Company, ceased operations in late 1952, after having operated in several localities in the county since 1886.

Of particular significance in the mechanization of the brick industry is the development of the brick lift fork, used to handle as many as 1,000 bricks as a single unit. This fork fits on conventional fork-lift trucks and grips and lifts several tons of brick without using pallets of any sort. This lift fork can be used to set green brick in the kiln as well as for drawing fired bricks from it, and saves the expense of stacking individual bricks by hand.

Dry-pan crushing and open-air drying limits the operation of most of the brickyards of the county to the summer months. Two yards, using tunnel driers, may operate the year around. Most yards are fully active from about March 1st to about November 1st, or as the rainy season dictates. Several reserve kilns of brick are usually made to be sold during the non-productive winter months, when the machinery may be under repair or alteration.

Sewer Pipe Plants. In 1953 four plants were using clay mined in Los Angeles County in the manufacture of sewer pipe. Two sewer pipe plants are at Los Nietos, one in Glendale, and one in Santa Monica. Pacific Clay Products plant No. 6, in Los Nietos, is the largest sewer pipe plant in the United States (Anonymous, 1950). Because sewer pipe, in being made to more exacting specifications than brick, requires a more vitreous, less porous body of greater strength, higher grade clays must be used. Refractory fire clays from the Alberhill and Corona region, Riverside County, are blended with common clay dug near the plants. The locally mined clay, added in minor proportions, lowers the maturing temperature.

In making sewer pipe the raw clays are first ground in dry-pan grinders and blended to desired proportions. The blended clay is then crushed, more thoroughly blended, screened and stored. From storage bins the prepared dry clay goes to combined pug-mill and auger machines for wet mixing. After de-airing in a vacuum appreciably greater than that required in brick manufacture, the stiff clay is extruded under great pressure through pipe-forming dies and cut at the desired length. The belled socket is then formed on the pipe, and its interior surface glazed, before it is removed for drying and later firing. An automatic jam-socket machine performs the entire process on the smaller sizes of pipe, from extrusion to up-ending it on a pallet for drying. Sizes of pipe over 8 inches and up to 39 inches in diameter are formed in a vertical press and require more handwork. Moisture content is carefully controlled during the drying period which takes about one day per inch diameter of the pipe. The pipe is then fired in the tunnel kiln or periodic down-draft brick kilns. Variations in the process of the plants are occasioned chiefly by their difference in sizes, the larger plants being almost completely mechanized. Pacific Clay Products Company conducted the research developing the continuous extrusion technique and such machinery as the auger press, the jam-socket pipe machine, the hydraulic pipe press, and other automatic machinery.

Roofing Tile Plants. Two plants, both located in Reseda, produce mission tile and tile shingles from clay mined in Los Angeles County. Clay is mined near the plants along the banks of the Los Angeles River and the processes are very similar in each plant. Clay, brought wet from the pit, is passed through rollers to break up large lumps and then fed directly to the tile machine. An auger forces the clay through the extruding die in a continuous curved sheet that is immediately cut, trimmed, and perforated automatically into individual tile. It is then placed by hand on mobile drying racks and taken to dry-rooms before firing. As a result of the lack of grinding and screening, the process is rapid, requiring only about 10 minutes for clay to pass from the pit to the dry-shed in finished form. Except in wettest weather mining may proceed, and year-round operation is possible by stockpiling a reserve of clay for use during rainy weather.

Data on Operations. A summary of data on 16 clay pits active in Los Angeles County in 1952 is given in the accompanying table. Details of location, and geologic, mining, and processing data are summarized for the several operations. The tabulated index includes brief summaries of data on about 50 additional clay product operations no longer active. More than 40 additional clay operations that were listed in previous reports of the Division of Mines have not been mentioned in the tabulated index, either because they are known to be solely manufacturing plants and not clay producers, or because information about them is too meager.

Diatomite

Diatomite is one of the most important nonmetallic mineral commodities being mined in Los Angeles County, in value per ton and total tonnage produced. Although minor production has been recorded from the defunct Featherstone (Tucker, 1927b, pp. 319-321) and

Banning (Crawford, 1896, pp. 642-643) quarries, since 1930 virtually the entire output in the county has come from the Dicalite deposit in the Palos Verdes Hills. Next to deposits at Lompoc, Santa Barbara County, this deposit is the largest commercial deposit of diatomite in California, the principal diatomite-producing state (Oakeshott, 1950a, pp. 152, 154).

Diatomite is a sedimentary rock consisting mostly of the siliceous skeletons of microscopic aquatic plants (diatoms) which lived in great abundance in Miocene seas. As the plants died their skeletons settled to the bottom of the seas, accumulating in layers as much as several hundred feet thick. With passage of geologic time the soft parts of the plants disappeared, leaving the resistant disc-shaped and needle-shaped skeletons. Accumulation of these formed a light-colored, light-weight, layered rock. The origin of the deposits has been discussed by Bramlette (1946).

Although diatomite was known and used prior to 1900, its production rose sharply after 1910. Production in Los Angeles County was first reported in 1897 and large-scale operation began in 1930 with the opening of the large deposits in the Palos Verdes Hills. Research, largely by the diatomite producers, steadily developed new uses and markets. War-time and post-war industrial expansion led to a wide demand for diatomite.

Over half the output is used in filter-processes for liquids of all sorts. The flat, porous, diatom skeletons, separated and cleaned at a processing plant, are added in fixed, minor amounts to the liquids to be filtered. As the liquid is expelled through a filter the particles pile up against the inside of the fabric. The moving liquid is forced through or between the tiny porous skeletons, straining out even the finest impurities. Diatomite products are also used as chemically inert, lightweight fillers in such industries as paint, rubber, plastic moulding, asphalt, and paper. The high melting temperature (2900°F.) and porosity of diatomite permit its use as a temperature insulator; bricks sawed from crude diatomite and manufactured pressed bricks are used in such apparatus as refrigerators and kilns. Diatomite is also useful, both in natural and calcined states, as a lightweight aggregate which improves workability of concrete mixes and eliminates excess water. Its light weight, high absorptivity, and large surface area led to its wide use as a catalyst, as an insecticide carrier, and as a fluffing agent for heavier dusts.

Production of diatomite has been reported from three areas in Los Angeles County: Santa Catalina Island, San Jose Hills east of Covina, and the Palos Verdes Hills. The Featherstone deposit in the San Jose Hills yielded diatomite chiefly for use in cement, prior to 1938 (Tucker, 1927b, pp. 319-321). Production is estimated from the size of the quarries to have been at least several thousand tons. Encroachment of real estate subdivisions and restrictive clauses in the title make future operation of this deposit unlikely.

On Santa Catalina Island a total of 10 tons of french chalk and infusorial earth of undetermined quality were reported (Crawford, 1896, pp. 642-643) produced in 1895-96. In 1937 experimental use of this material was made for pipe coatings, but no production resulted.* De-

* Renton, Malcom, Santa Catalina Island Co., Avalon, Personal communication, 1953.

FIGURE 7. Aerial view south toward the diatomite operation of Dicalite Division of Great Lakes Carbon Corporation in the Palos Verdes Hills. *Pacific Air Industries photo courtesy Dicalite Division of Great Lakes Carbon Corporation.*

posits of diatomite also are known in the Santa Monica Mountains, the most extensive ones being northwest of Santa Monica near Point Dume, but no production has been reported (Sampson, 1937, p. 202).

*Dicalite (Walteria, Dicalite Co.).** Location: secs. 28 and 29, T. 4 S., R. 14 W., S.B.M., on the northeast edge of the Palos Verdes Hills, about half a mile due south of the community of Walteria, and about 20 airline miles due south of central Los Angeles. Ownership: 308 acres belonging to Palos Verdes Corporation, Rolling Hills, California, are leased to Dicalite Division of Great Lakes Carbon Corporation, General Petroleum Building, 612 South Flower Street, Los Angeles, California.

The Dicalite operation in the Palos Verdes Hills ranks third in production of diatomite in California and is currently one of the most important of the active mining operations in Los Angeles County. Diatomite is mined from the upper Miocene Valmonte diatomite member of the Monterey formation, widely but discontinuously exposed along the northeast edge of the Palos Verdes Hills. In this area the upper part of the Valmonte member consists of alternating units of laminated diatomite and massive diatomaceous mudstone (Woodring, Bramlette, and Kew, 1946, pp. 120-121), of which only certain members provide diatomite of suitable grade and quantity for mining. The Valmonte strata generally strike a little west of north and dip 20° to 35° NE, but locally distorted beds dip more than 50°. Several units within the Valmonte member, each separated by a hundred feet or more of non-commercial material, contain enough diatomite to have been mined extensively.

In the area of current operations diatomaceous earth and clay alternate in strata as much as several feet thick. Operating history indicates that, of the material actually removed from the ground so far, more than half is overburden and non-diatomaceous material. Small-scale faulting has fractured some zones and has offset bedding planes. On the east the Valmonte member is overlain in large part by the Malaga mudstone member of the Monterey formation, in and adjacent to which several sand and gravel pits are being operated.

In 1929, the Dicalite Company first leased the deposit, built its plant, and commenced mining. Through the depression years the operation expanded steadily and research facilities were kept active. In 1944 Dicalite Company was purchased by Great Lakes Carbon Corporation and is now known as Dicalite Division of that corporation. From time to time since the company's Lompoc quarry in Santa Barbara County was opened during World War II, crude diatomite has been trucked from that quarry to the Walteria plant for processing.

The workings opened during the life of this operation have been restricted to an area about a mile wide and more than 2 miles in length. Most of the mining has been confined to surface excavations which have probably nowhere exceeded 100 feet in depth. In 1953 mining was carried on at three localities, each essentially a clean-up operation in a spot previously quarried. During early stages of the operation small tonnages of diatomite were removed through haulage adits beneath glory holes. Mining is done entirely without explosives. Diesel-powered

* Data for this description were supplied largely by R. L. Douglas and A. K. Muir of Dicalite Division of Great Lakes Carbon Corp., General Petroleum Building, 612 South Flower St., Los Angeles.

shovels cut 5- or 6-foot benches and load the material on dump trucks. One man with a hand shovel assists the power shovel in the separation of the thin beds of crude diatomite from non-commercial material. Carryalls and slushers are also in use.

The crude diatomite is heaped in several storage piles of different grades and allowed to dry before being trucked to the mill. In mid-1953 mining was being done by contract with Clyde L. Sheets Company, General Engineering Contractors, Gardena, with pit supervision by Dicalite engineers.

Zones containing diatomite of commercial grade are exposed and followed on the surface by bulldozing and careful mining, and explored underground by test borings. Commercial diatomite commonly may be distinguished from waste by color and general appearance, but samples are taken frequently and thoroughly tested in a laboratory. The mining of a particular part of the deposit is terminated when the amount of overburden or of interlayered clay becomes too great for economic removal. Just beneath the surface layer of soil overburden the diatomite is contaminated with water-leached impurities, whereas at great depths the material is unsatisfactory because it is contaminated with dark residual organic residue that has not been leached from the strata.

Upon delivery by truck to the mill, the crude diatomite is first crushed in a hammer mill to about 1-inch size and then stored in silos before further processing. The adsorbed water is next removed by flash drying at 800°-900° F. Milling blowers impart speeds of 50 to 100 miles per hour to the dried material, reducing it to powder size, after which the material is conveyed entirely by air currents or gravity. Separation of different types of diatomite by particle size is then effected by air classification in various cyclones, and heavy particles such as sand are removed. Diatomaceous material thus segregated is then calcined at temperatures from 1600° to 2000° F. in a gas-fired inclined rotary kiln 100 feet long and 8 feet in diameter. After cooling, the material is air-classified to final grade and sacked in 50-pound bags for shipment. The mill operates 24 hours a day, 7 days a week, but mining is done only on the day shift, 6 days a week. Approximately 100 men are employed to conduct the entire operation.

Three general types of diatomite products are sold: natural, which has been dried, milled, and air classified; calcined, which has been dried, milled, subjected to high temperature burning, and air classified; process calcined, or white, which has been dried, milled, subjected to high-temperature fluxing, and air classified.

These products are utilized in the processing of a wide variety of items; but their major uses are as filter aids to facilitate the clarification of food products, pharmaceuticals, and chemicals; as insulating materials for use around boilers and furnaces; as paper aids, to improve quality and appearance; as a flatting and extender pigment for paints, varnishes, and other protective coatings; and as fillers in many products. Specific uses are found in practically every field of industrial endeavor, and markets include virtually all foreign countries as well as the United States.

Feldspar

Small amounts of plagioclase feldspar have been mined from anorthosite bodies in the Soledad Canyon area in the western San Gabriel Mountains. The anorthosite bodies, locally associated with bodies of granite, occupy a zone several miles wide and about 12 miles long extending from Lang east to Ravenna. The material mined consisted mostly of basic andesine, a calcic plagioclase feldspar. It has been used as an abrasive in cleansers, for ceramic glazes, and in poultry grits. Tests were made by Karl Vail in 1941 to determine its effectiveness in counteracting alkali reactivity of concrete aggregate, but no production resulted.

Only a small amount of potash feldspar has been mined in Los Angeles County (see Silica Mining and Products Company in feldspar section of tabulated index). Since 1926 no potash feldspar of proved commercial interest has been reported.

Fluorspar

Purple and green masses and cubes of fluorite have come from one locality north of Azusa (Murdoch and Webb, 1948, pp. 146-147), but no commercial production of fluorspar has been reported from Los Angeles County.

Graphite *

In Los Angeles County graphite occurs in crystalline limestone, quartzite, and feldspar-sillimanite-tremolite schists. The graphite present in the metamorphic rocks in the county is amorphous, consisting of fine crystalline grains. Several attempts have been made to recover graphite from rocks containing from 7 to 17 percent graphite. In the 1930s competition provided by higher-quality imported material resulted in the closing of the few mines in the county.

Prior to 1931 a deposit in the Sierra Pelona near the head of San Francisquito Creek was worked at intervals for more than 25 years. This deposit, a graphite schist formed through metamorphism of carbonaceous sediments, yielded a maximum of 10 tons of graphite schist daily. Three samples, analyzed by the United State Geological Survey, ranged from 7.29 to 17.48 percent graphite (Oakeshott, 1950d, p. 169). A mill at the deposit operated continuously from 1918-20 and supplied some of the local needs for foundry facings, paint, and lubricants.

A deposit on the north slope of the Verdugo Hills, 2½ miles northwest of Montrose, was known as early as 1889 and yielded some graphite in 1920. In the San Gabriel Mountains deposits in upper Kagel Canyon and in Pacoima Canyon also have yielded graphite. A 50-ton concentration mill in Kagel Canyon produced small-flake graphite between 1918 and 1928. The material treated contained 7 to 15 percent graphite in flakes less than 0.25 millimeter in diameter.

Early in 1953 exploration and development work was commenced on graphite occurrences at the Champion gold mine in the Mint Canyon area 6 miles west of Acton. Graphite schist assaying as high as 15.62 percent graphite is exposed in various workings of the old Champion gold mine (see in gold section of tabulated index).

* Beverly, 1934; Oakeshott, G. B., 1937, pp. 245-248; 1950d.

Gypsum †

In Los Angeles County gypsum and gypsiferous beds are found principally in sedimentary rocks of the Oligocene (?) Vasquez series. Only two deposits have been mined; the larger one is in the San Andreas fault zone near Palmdale and the other is in the Mint Canyon area.

The largest mining operations, resulting in the production of at least 10,000 tons of gypsite were at the Palmdale deposits about half a mile southwest of Palmdale. Mining was begun in 1892 by the Alpine Plaster Company, and in 1910 both this company and the Fire Pulp Plaster Company operated mines and calcining plants. Operations were abandoned by 1915 when the easily obtainable gypsite had been exhausted.

A few tons of gypsum were taken from the Charlie Canyon deposit 7 miles north of Castaic in 1904 and 1905.

Iodine

All the crude iodine recovered in the United States and about one-third of the country's requirements are produced in Los Angeles County (Ver Planck, 1950, p. 230) from the brines of certain oil wells in the Los Angeles basin. Statistics on the production of iodine are not available for recent years, but in 1945-46 the county yielded 1,224,598 pounds valued at $1,563,069. California's iodine recovery industry started in 1928, and three producers became active. Since the General Salt Company ceased production in 1936, the Dow Chemical Company and the Deepwater Chemical Company have been the only active producers. In 1945 four plants were in operation, one each at the Dominguez, Seal Beach, Playa del Rey, and Inglewood oil fields. Methods of recovery have been described by Ver Planck (1950, pp. 230-233).

Limestone, Dolomite, and Cement *

Production of lime and limestone in Los Angeles County dates back to the Spanish period prior to 1800. Lime kilns were built by the Spaniards and early American settlers for burning locally mined limestone to provide lime mortar for construction purposes. With the advent of portland cement, lime mortars were supplanted by cement mortars, and masonry by concrete. Although lime products still are important constituents in various construction materials the largest tonnage of lime used by construction industries is in the form of portland cement.

Calcium carbonate ($CaCO_3$), alumina (Al_2O_3), and silica (SiO_2) are the three essential constituents used in the manufacture of portland cement. The most common source of calcium carbonate is high-calcium limestone; some form of clay usually supplies the alumina and silica. Being of low cost per unit weight, cement is generally manufactured as close to centers of population as the availability of raw materials will allow in order to minimize transportation expenses. Although the construction industry in the Los Angeles area consumes the bulk of the cement manufactured in southern California, limestone suitable for cement manufacture is not abundant in the county.

† Ver Planck, 1952, pp. 40, 57, 125; Hess, 1920, p. 75.
* Bowen, 1950, pp. 138-142.

The portland cement industry in southern California has developed in San Bernardino and Riverside Counties where large deposits of high-calcium limestone exist. The only cement plant in Los Angeles County, that of the Blue Diamond Corporation, receives most of its materials from San Bernardino and Riverside Counties.

Although deposits of limestone in the pre-Cretaceous crystalline rocks in the Santa Monica Mountains have been investigated for possible use in portland cement none have been placed in operation for this purpose. Many limestone deposits in the San Gabriel Mountains contain a high percentage of magnesium, which is highly detrimental in portland cement. Of particular potential commercial interest are the limestone deposits of the Wrightwood district in Los Angeles and San Bernardino Counties.

Small amounts of limestone, dolomitic limestone, and calcareous material have been mined in Los Angeles County, yielding material for poultry grits, roofing granules, building stone, soil additives, and other minor uses. These operations have generally been small and intermittent. In 1952 production of limestone in Los Angeles County was restricted to the two operations described below. The Amercal deposits yielded roofing granules and soil conditioner from dolomitic limestone and the Santa Ynez limestone quarry yielded building stone.

Amercal Mine. Location: sec. 19, T. 4 N., R. 8 W., and sec. 24, T. 4 N., R. 9 W., S.B.M., in Grandview Canyon, on the north base of the San Gabriel Mountains, about half a mile south of Largo Vista, and about 23½ airline miles southeast of Palmdale. Ownership: Amercal Mining Company, Inc., Robert L. Griffin, Jr., president, 16321 Lakewood, Bellflower, California, owns and works three unpatented claims.

The Amercal deposit, although not extensively developed, has yielded a modest tonnage of dolomitic rock for use as roofing granules since 1949. The rock is a dolomitic limestone. The deposit consists of several irregularly exposed bodies of the dolomitic rock in metamorphic rocks of the San Gabriel Mountains.

The rock being mined is coarsely crystalline and light gray to white. Bodies of it intimately interfinger with and are enclosed by a biotite-rich granitic rock which ranges in color from pink to gray and commonly has well-defined gneissic texture. Foliation planes in the gneissic phase generally strike N. 40° E. and dip 60° NW., but other attitudes are common.

The bodies of dolomitic limestone constituting the deposit are discontinuous in outcrop and irregularly distributed in the country rock. Where exposed in the pits the rock is fractured and its contact with the country rock disrupted by movement of the shattered rock. The discontinuity and fracturing of the rock are apparently related to movements on the San Andreas fault zone, about half a mile south of the deposit.

The body of rock now being mined is at least 100 yards wide and a quarter of a mile long, but its extremities are hidden under alluvium. The deposit is mined by open-pit methods. Three pits have opened along the canyon bottom within a quarter of a mile of each other. The largest pit has a vertical face about 50 feet high, a base 50 feet wide, and has been cut about 40 feet into the hill. The other pits are slightly smaller.

For use in roofing granules the rock must be kept free of admixtures of overburden and country rock. Each pit is mined until separation of waste from desirable rock becomes unfeasible; then a new pit is opened. To move as infrequently as necessary, yet to mine only satisfactory rock is a continual problem in this area.

After the rock is drilled and blasted, it is sorted by bulldozer, loaded on trucks by diesel-powered shovel, and hauled three-quarters of a mile to a mill. There the rock is crushed in a 15 by 24 inch jaw crusher and a Sturdevant Gyro crusher, then elevated for treatment by screens and air blowers before dropping into bins for sacking. The roofing granules pass a $\frac{3}{8}$-inch screen and are caught on a 10-mesh screen. The fines are sold as a soil conditioner. The mill is compactly arranged in a single metal structure and has a capacity of about 30 tons a day. Four men handle the entire mining and milling operation.

Santa Ynez Deposits. Location: sec. 16, T. 1 S., R. 16 W., S.B.M. (projected), on the east side of Santa Ynez Canyon, about $3\frac{1}{2}$ airline miles northeast of Topanga Beach, and about 5 airline miles northwest of Santa Monica. Ownership: Mountain Park Company, 17201 Sunset Boulevard, Pacific Palisades, California, owns a large tract, leases quarry rights jointly to Santa Monica Rock Company, A. H. Braun, president, 2018 6th St., Santa Monica, and Flickinger and Welker, general contractors, 2719 West Vernon, Los Angeles, California.

The Santa Ynez Canyon deposits, although incompletely developed have been noted to be "probably the most important limestone deposit in the county" (Logan, 1947, p. 248). The deposits and general geological features of the area have been described in detail by Hoots (1931) who states "some of these deposits are of sufficient size and purity to warrant serious consideration of the use of this limestone in the manufacture of cement".

The limestone is algal in origin, and occurs as lenses in the Paleocene Martinez formation, widely exposed in this area. The deposits are discontinuous white reefs from a few feet to several hundred feet thick and as much as 4,000 feet long. Exposures of the rock have a characteristically spotted appearance caused by abundant, nearly white, irregularly shaped algae and algal colonies in the light brown or gray limestone matrix. Seams of brown argillaceous material are abundant, commonly paralleling the bedding plane. Both the upper and lower contacts of the limestone are gradational into limy shale.

Limestone has been quarried from two sites, about half a mile apart and on separate lenses; one lens is near the canyon bottom and the other is high on the east slope. The lower quarry was opened about 1928 and the more productive upper one a few years later. The lower quarry has been idle since 1952 because of road washouts. The upper quarry covers several acres, the face being about 50 feet high and over a hundred yards long.

The limestone ledge at the lower quarry site is about 2,000 feet long and as much as 100 feet thick. It strikes slightly north of west and dips about 45° S. A 200-foot shaft on a 45° incline passed from limestone into limy shale. The upper quarry is in a limestone lens about 700 feet in maximum thickness and 4,000 feet in length, by far the largest deposit in this area. This lens strikes northwestward and dips about

40° SW. One estimate placed the amount of limestone in this deposit above the level of the canyon bottom at 20,000,000 tons (Hoots, 1931, p. 134). In 1928, this limestone was tested for use in cement. One plan was to crush it to minus 200-mesh size at the deposit and transport it by gravity as a slurry in 10- or 12-inch pipes to shipping facilities at the coast, a distance of 4½ miles. This plan met formidable opposition from property owners in the vicinity, and was abandoned.

Prior to 1931 limestone from the lower quarry was used locally to surface roads. From 1936 to 1944 several thousand tons of rock were removed from both quarries by W. F. Glasser Inc., 713 North Sepulveda, Brentwood Heights for use in various construction projects. The present lessees have been continuously active on a small scale since early 1947, the Santa Monica Rock Company being the more active. A total of several thousand tons of dimension stone has been produced in this period for the construction of buildings, walls, and fireplaces. Flickinger and Welker generally quarry larger sizes of stone for waterfront and other large construction projects, and use less limestone than sandstone from nearby sites.

Open-pit methods are used, the fractured condition and fissile argillaceous seams in the limestone making blasting unnecessary. Power shovels or bulldozers have been used, but much of the rock is lifted from the quarry face to trucks by hand and is occasionally broken by sledge hammers or crow bars.

Mica

Small amounts of muscovite mica are present in granitic pegmatite bodies in the San Gabriel Mountains. None of the deposits has proven capable of sustained production. See tabulated index.

Mineral Paint

Showings of mineral paint pigments are known in Los Angeles County but little production has resulted. Ocherous pigments from Santa Catalina Island and from beach bluffs north of Redondo Beach have been tested. Clay containing boric acid is reported to have been used to a limited extent as pigment in kalsomine paint for plaster walls. Small amounts of graphite from several localities in the county have been used for paint pigment. Property descriptions are summarized in the tabulated index.

Rock Products

In Los Angeles County the rock products industry ranks second to the mineral fuels industry both in value and quantity. The categories of rock products discussed in this section are (1) broken and crushed stone used primarily for riprap and fill in waterfront projects; (2) crushed stone (decomposed granite) used mostly for road base; (3) dimension stone, including flagstone, building stone, and facing stone; (4) miscellaneous rock products including diatomaceous shale, volcanic ash, and burned shale "volcanic rock"; (5) sand, gravel, and crushed rock *, used primarily for concrete aggregate; (6) soapstone;

* In technical usage "stone" is the term applied to material that has been quarried from larger masses of rock, whereas "rock" is applied to material in place, before it is broken or cut. In this report, however, the widely accepted usage of the term "crushed rock" is retained for crushed alluvial material used primarily for concrete aggregate.

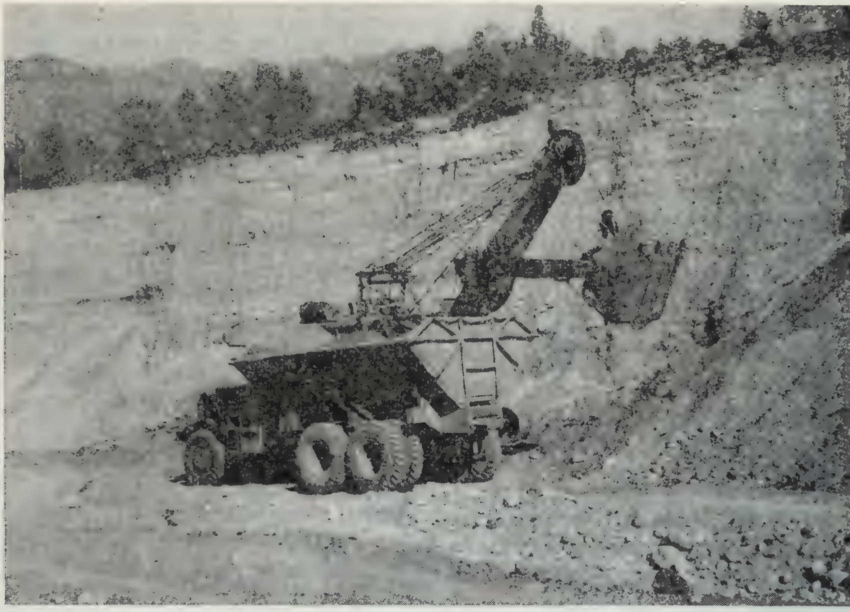

FIGURE 8. Mining sand and gravel at the Osborn Company pit in Eaton Wash. View northeast; San Gabriel Mountains in background.

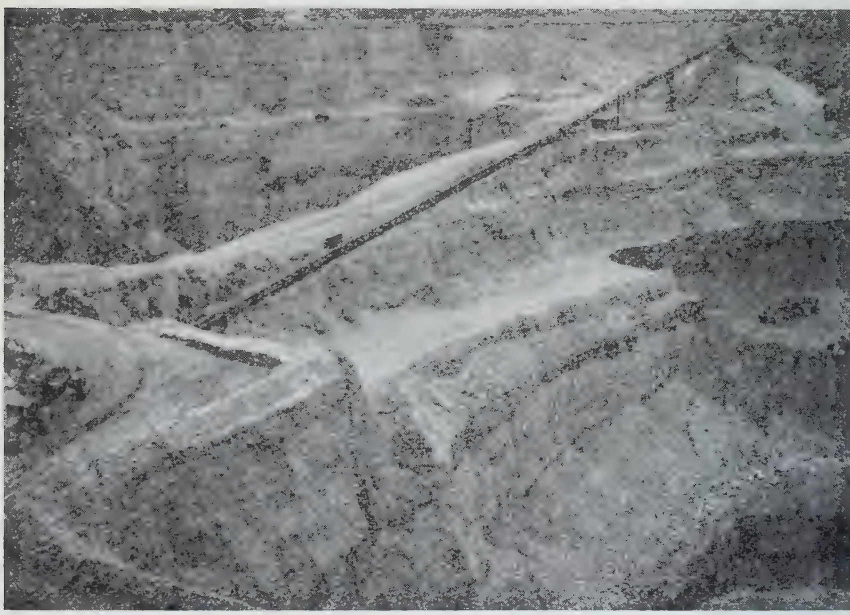

FIGURE 9. View southeast toward Manning Bros. sand and gravel pit near Irwindale. Active face middle right; bottom dump truck just leaving dumping hopper at left edge; belt conveyor to surge pile and reclaiming belt at upper right.

and (7) specialty sands, including sand for foundry, locomotive, miscellaneous, and sandblasting uses. A complete listing of all rock products operations in the county may be found in the tabulated index.

Appreciable tonnages in all categories are produced in Los Angeles County, the most notable being sand, gravel, and crushed rock. In 1950 the county yielded a total of 15,127,334 short tons of sand, gravel, and crushed rock valued at $9,835,428 (California Div. Mines, 1952a), nearly half of California's total commercial production (Chandler and Tucker, 1953, p. 1088).

Broken and Crushed Stone

Broken and crushed stone, in blocks weighing as much as several tons, is now quarried in three localities in Los Angeles County, two on Santa Catalina Island and the other in the Palos Verdes Hills. Large stone is used almost exclusively in harbor and waterfront construction where it is employed as riprap, ballast, dike core rock, and fill. Constant wave attack on sea front areas requires continuous maintenance of sea walls. Cyclopean concrete, in which stone blocks weighing 3 or 4 tons are surrounded by concrete grout, is also used for this purpose. Land in the harbor area, that has subsided as much as 10 or 15 feet, requires large quantities of stone fill material from sources outside the sinking area. Smaller sizes of crushed stone and crusher-run base are used in large tonnages for road base.

Most outcrops of massive rock in Los Angeles County are too fractured and decomposed to be suitable sources of large stone. Granitic rock has been quarried at several places in the San Gabriel Mountains for specific projects such as facing for flood control dams. Strong, undecomposed granitic rock, rarely procurable in the county in pieces weighing more than a ton or two, is brought in from Riverside and San Bernardino Counties when required. The principal source of large stone in Los Angeles County is Santa Catalina Island. Barges bring stone to the mainland harbor from two active quarries on the island. Broken stone in smaller sizes is quarried at one site in the western Palos Verdes Hills.

Usual sizes of broken stone are (1) A-rock, a mixture of pieces weighing from 1 to 10 tons, but including pieces weighing as much as 30 or 35 tons when required; (2) B-rock, or riprap, as much as 2 tons in weight and at least 12 inches in diameter; (3) C-rock, from 6 to 12 inches in diameter; and (4) crusher-run base, less than 2 inches in diameter with all the fines. Modifications of these sizes are produced as required.

Several types of stone have been quarried on Santa Catalina Island. At the Pebbly Beach quarry of Connolly-Pacific Company, south of Avalon, compact metamorphosed conglomerate and graywacke is quarried in blocks as large as 35 tons. The stone is blasted from 150- to 200-foot faces by coyote-hole methods, with secondary blasting of large pieces. Diesel shovels load 15-yard trucks, which dump in huge metal boxes called skips. A crane of 30-ton capacity sets the loaded skips on barges. Larger pieces are handled in chain slings.

At the Empire quarry of Graham Brothers, Inc., partly decomposed dioritic rock is quarried. Little blasting is required. The product is generally of smaller size than at the Pebbly Beach quarry. A 100-foot

face has been excavated by a diesel shovel which loads trucks for the short haul to the crusher. Stone larger than 12 inches goes over a grizzly and rolls downhill to the loading beach. Minus 12-inch stone is crushed and sorted to required sizes. A walking Monighan that has a 135-foot boom loads all stone to barges of about 1,000-ton capacity. Tugs haul the barges to the mainland in 5 to 7 hours.

In the western Palos Verdes Hills the Livingston Rock and Gravel Company has produced several sizes of crushed stone, mainly smaller than 6 inches. The principal tonnage in 1952 was crusher-run base of minus $1\frac{1}{8}$-inch size. The rock in the quarry is chiefly middle Miocene altered basalt (Woodring, Bramlette, and Kew, 1946, pl. 1) but dolomitic limestone and Monterey shale of the same age border the pit and also occur as lenses, and are sometimes mined. Benches 60 feet high are drilled and blasted. Broken stone is loaded in trucks by power shovels and carried to the mill. A large jaw crusher, several rolls, and appropriate screens produce the sizes of stone desired. Much of the product is loaded on barges for use in the harbor area as core rock in dikes. Some uncrushed pieces are used for riprap.

Crushed Stone (Decomposed Granite)

At several places in the county, crushed stone known as ''decomposed granite'' (''DG'') has been mined, primarily for use in road construction. Except for crushing, this material is not graded or processed before use. Most of the material mined is not actually granite, but sandy cobble conglomerate made up largely of granitic debris. The material is not suitable for use as sand, gravel, and crushed rock aggregate because of its decomposition and high clay content. Some variation in character of decomposed granite is acceptable, but too great a percentage of clay and fines makes the material unsatisfactory. Most of the material now produced is obtained in the Montebello Hills from the Pleistocene La Habra sandy conglomerate (Sheller, 1952) which overlies the upper Pliocene Pico formation and is as much as 500 feet thick (Stolz and Woodward, 1943, p. 336). One company mines decomposed Jurassic (?) granitic rock in the Santa Monica Mountains.

Mining is done by open-pit methods. Blasting is not required. Power shovels, bulldozers, and skip loaders load the material into crushing units that are commonly portable. Material is crushed by jaw crushers or hammer mills in closed circuit with vibrating screens. All material passing the screens, which usually have openings of about $1\frac{1}{2}$ inches, is loaded by belt conveyor into storage bins or directly to trucks for haul to the job.

Only five operators are known to the writer to be producing decomposed granite commercially. Several hundred localities in the county have yielded decomposed granite in the past, being operated by contractors whenever necessary to procure materials for specific construction projects. The locations, status, and specifications for most of these deposits are listed with U. S. Army Engineers, California State Division of Highways engineers, and Los Angeles County Road Department engineers.

Dimension Stone

The term ''dimension stone'' is applied to blocks or slabs of natural stone, most of which are cut or broken to definite shapes or sizes (Run-

ner and Jensen, 1951, p. 1134). In Los Angeles County three classes of dimension stone have been produced: flagstone, building stone, and facing stone. Flagstone and building stone are produced in minor amounts from rocks of the Pelona schist series in Bouquet and San Francisquito Canyons (see below). Building stone, consisting of Upper Cretaceous sandstone of the Chico formation was produced in large tonnages in the Chatsworth area in the early 1900s. (Merrill, 1919, pp. 482-483). Large blocks from the Chatsworth quarries were used in the San Pedro breakwater, and several churches, large buildings, and private residences were constructed from this stone. Several quarries were active but all were shut down by 1915 and no subsequent activity has been reported.

Small tonnages of sandstone and limestone have been produced for building stone in Santa Ynez Canyon in the Santa Monica Mountains.

Facing stone was produced prior to 1914 from talcose serpentine rock at the Banning quarry on Santa Catalina Island, and used for monumental, sanitary, and electrical purposes.

Other types of building stone that have been mined in Los Angeles County (Tucker, 1927b, pp. 330-332; Aubury, 1906, pp. 28, 128-131, 147, 154-155) include gneiss, granite, and trachyte, but little if any of these materials has been produced for many years. The general features of all of these dimension stone operations are summarized in the tabulated index of mining properties accompanying this report.

Flagstone and building stone have been produced from small quarries in the Bouquet Canyon and San Francisquito Canyon areas for many years. Flagstone is produced mainly in San Francisquito Canyon, whereas the blockier pieces sold as building stone are obtained from a score or more of quarries widely dispersed in these areas. Much of the stone is used locally, but it is also distributed by dealers in the Los Angeles area for use in walls, gardens, and buildings.

The stone is obtained from gray quartz-mica-plagioclase schist and chloritic schist of the pre-Cambrian (?) Pelona schist series (Simpson, 1934, p. 380). In the quarry areas the schistosity ranges in strike from N. 45° E. to N. 65° E. and in dip from gentle to steep. Intricate contortion is uncommon. The schistosity plane is the only plane of pronounced fracturing. Thin slabs of large size are uncommon and careful hand splitting is required in nearly all quarries. These factors are the principal deterrents to expansion of the industry.

All the flagstone and building stone quarries are small open-pit operations. Quarries are usually in steep hillsides where the schist is well exposed and relatively uncontorted. Blasting and bulldozing expose suitable faces. Slabs and blocks are broken out and split by hand with the aid of crowbars and hammers and chisels. Pieces are then loaded onto trucks and hauled away for sale. The largest quarries visited by the writer have each yielded about a thousand tons of commercial rock.

Several quarries are on placer claims, but most operations are on National Forest land withdrawn from mineral entry. Special use permits are granted for removal of stone from such areas. If the rock is to be sold, a fee of 25 cents per ton produced is paid to the Forest Service. If the rock is to be used by the operator for private projects, no matter where, no fee is charged.

Rock
Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Sand, Gravel Crushed Rock									
Arrow Rock Co. (Duarte plant) 1137 Meridian St., Duarte	36	1N	11W	SB proj.	Continuous since 1929.	San Gabriel River wash; various granitic, metamorphic rock types.	About 100 acres.	¾-yd. diesel shovel; 20-ton end-dump trucks; ¼-mile average to plant.	(varies) × 1370 ft. × 125 ft. max. (about 30 acres.)
Arrow Rock Co. (Sun Valley plant) 11-670 Wicks St., Sun Valley	19,30	2N	14W	SB proj.	Opened 1936 (Mahan Co.) Arrow Co. continuous since 1938.	Big Tujunga River wash; various granitic, metamorphic rock types, little clay. Sand: gravel 60:40 top 60 ft., 50:50 to 80-ft., 40:60 below 80 ft.	44½ acres.	2- and 1½-yd. diesel shovels, 20-ton end-dump trucks to primary crusher. Belt 500 ft. to surge pile; 1000 ft. to plant.	(varies) × 85 ft. av. (about 22½ acres.)
Azusa Rock & Sand Co., Box 575, Azusa (plant at Mira Loma and Paramount, Azusa	3, 4, 33,34	1S 1N	10W 10W	SB SB proj.	Opened about 1930 (Woods Rock & Sand Co.). Azusa Co. continuous since 1932, present plant built 1946.	San Gabriel River wash; variousgranitic and metamorphic rock types, little clay.	200 acres.	3½-and 1½-yd. shovels, 30-ton bottom-dump trucks ¼-¾ mile to primarycrusher. 36″ belts to surge pile, plant; total 1019 ft.	½ mi. × ½ mi. ×130-140 ft. av.
Richard R. Ball P.O. Box 96 Walteria (Plant south end of Hawthorne Blvd.)	28	4S	14W	SB proj.	Opened 1922. Ball active since 1925.	Pleistocene San Pedro sand; of terrace or beach origin. Sand and gravel indicative of predominantly granitic source rocks. Very little larger than ¾-in. Hillside pit.	13 acres total; about 6 acres of usable material.	Slackline cable dragline. Dragline drags about 600 ft. from working face to plant.	(varies)×125-ft. face. (about 6 acres.)
Blue Diamond Corp. (Roscoe plant) P.O. Box 2678, Terminal Annex, Los Angeles 54. (Plant 8001 Fair Ave., Sun Valley)	31,32	2N	14W	SB proj.	Blue Diamond continuous since plant built in 1929.	Big Tujunga River wash; various granitic, metamorphic rock types. Sand: gravel 60:40 top 60 ft., 48:52 for next 90 ft.	About 100 acres.	2½-yd. electric shovel, and 1½-yd. dragline scarifier from bank above. Hopper to 36-in. belt to primary crusher, total 4700 ft. to plant.	Old pit: 800 ft. ×800 ft.×135 ft. max. Active pit: 500 ft.×800 ft.× 135 ft. max.

products.
active in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
30×36-in. jaw, 3-ft. and 4-ft. Symons cone and AC 322 gyratory crushers. Standard screening and washing equipment.	Washed sand and gravel and crushed rock in all standard sizes.	325 tons per hour.	Plant: 8 Total: 65 (truckers included)	325-ft. water well in usable material to the bottom. Main office at Sun Valley plant.
30×36-in. jaw, 2-ft. Telsmith cone crushers. Trommel scalping screen. Standard sizing screens and washing equipment.	No. 1, 2, 3, 4, 5 crushed rock and gravel; concrete and plaster sand (washed).	300 tons per hour.	Plant: 8 Total: 72	500-ft. water well in usable material to the bottom.
32-×40-in. jaw, 4¼ ft. and 4 ft. Symons cone crushers. 8-AC vibrating screens. Standard washing equipment.	All commercial sizes of sand and gravel (washed) and crushed rock.	450 tons per hour.	Total: 214 (two shifts)	324- and 630-ft. water wells entirely in usable material. Minor amount of placer gold recovered as by-product.
No crushing required. Standard screening, washing equipment. Oil-fired drying kiln.	Concrete and plastic sand (one product); kiln-dried filter gravel, sandblasting sand, roofing gravel, nursery sand.	About 30 tons per hour.	Total: 6	Underlain by Valmonte diatomaceous earth on the west.
30×42-in. jaw, No. 37 Kennedy, No. 7 Newhouse, 4 AC 322 gyratory crushers. AC, Ty-Rock mechanical screens. AC washer screens and log washers.	No. 3, 4 crushed rock and rock dust; No. 2, 3, 4, gravel; coarse and fine sand (unwashed); concrete and plaster sand (washed).	350 tons per hour.	Production: 18	222-ft. well encounters weak material near bottom; 135 ft. is economic bottom for present specifications.

Rock
Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Blue Diamond Corp. (Santa Fe plant) P.-O. Box 2678, Terminal Annex, Los Angeles 54 (Plant 890 E. Live Oak, Duarte)	1	1S	11W	SB proj.	Opened 1948, continuous since then.	San Gabriel River wash; various granitic and metamorphic rock types, little clay.	About 200 acres.	2½-yd. electric shovel. Hopper to 36-in. belt for 1600-ft. haul to plant.	600 ft.×800 ft. ×70 ft. max.
California Materials Co., 9228 Tujunga Ave., Sun Valley (John D. Gregg, pres., P.O. Box 110, Whittier)	19,20 29,30	2N	14W	SB proj.	Opened 1933 (John D. Gregg Co.) California Materials Co. since 1950.	Big Tujunga River wash; various granitic, metamorphic rock types.		6-yd. electric shovel, with scarifier from bank above. Hopper to primary crusher on pit car on rails. 36-in. belt conveys 3300 ft. to plant.	Active pit: 600 ft. ×600 ft.× 100 ft. Old pit: 500 ft. × 600 ft. × 100 ft.
Chandler's Palos Verdes Sand and Gravel Co. Box 295, Lomita (Plant 26311 Narbonne, Lomita)	35	4S	14W	SB proj.	Continuous by Chandler since opened in 1937.	Pleistocene San Pedro sand of terrace or beach origin; content indicates predominantly granitic parental rocks. Very little larger than ¾-in. Hillside pit.		Slackline cable draglines. Draglines drag over 1000 ft. from working face to plant.	⅓ mi. × ½ mi. × 150-250 ft. face.
City Rock Co. 10900 Cottonwood, P.O. Box 8, Sunland	9,10	2N	14W	SB proj.	Opened 1925. City Rock Co. since 1939, continuous since 1943.	Big Tujunga River wash; various granitic, metamorphic rock types.	282 acres.	Diesel shovel. Trucks haul about ½ mile to plant.	
Consolidated Rock Products Co. (Hewitt plant) Box 2950 Terminal Annex, Los Angeles 54. (Plant 7209 Laurel Canyon Rd., N. Hollywood)	1	1N	15W	SB proj.	Opened early 1920s by Consumers Rock & Gravel Co. Merged with Consolidated in 1929. Intermittent activity since 1929.	Big Tujunga River wash; various granitic and metamorphic rock types. Little larger than 4″.	About 40 acres.	1½-yd. gas shovel. Trucks haul about ¼ mi. to belt for 100-yd. haul to primary crusher.	1000 ft. × 1000 ft. × 100 ft. max.
Consolidated Rock Products Co. (Irwindale No. 6 plant) (Plant 4829 Irwindale)	8, 9	1S	10W	SB proj.	Opened 1927 (John D. Gregg). Continuous since merged with Consolidated in 1929.	San Gabriel River wash; various granitic and metamorphic rock types.	372 acres.	6-yd. electric shovel Hopper feeds 42-in. belt for 1000-ft. haul to primary crusher; 2660-ft. haul to plant on 36-in. belt.	Abandoned pit: 300 yds.×800 yds.×100 ft. Active pit: (varies)×600 yds. ×152 ft. (202 acres) max.

roducts.—Continued.
ctive in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
8×36-in. jaw, Traylor and AC 322 gryatory crushers, 7-ft. Marcy ball mill. Standard screening and washing equipment.	All standard sizes of sand and gravel (washed) and crushed rock.	325 tons per hour.	Production: 15	300-ft. water wells entirely in usable material. Main office 1650 S. Alameda St., Los Angeles.
4×36-in. jaw, AC Newhouse gyratory crushers. Trommel scalping screen, AC, Conveyor Co., and revolving classifying screens. Drag washers.	No. 2, 3, 4, 5 crushed rock. Standard sizes of sand and gravel, washed and unwashed.	450 tons per hour.	Plant: 40 Pit: 5	400-ft. water well.
No crushing required. Standard screening and washing equipment.	Plaster and concrete sand (washed), ½- and ¾-in. rock.	400 tons per hour.	Total: 75	Near 250 ft. below original surface excessive clay is present.
tandard crushing, screening and washing equipment.	Standard sizes of sand and gravel (washed) and crushed rock.	About 250 tons per hour.	Total: 70	
0- × 48-in. jaw crusher. Standard secondary crushing, screening, washing equipment.	No. 3, 4, crushed rock, dust. No. 3, 4 gravel and concrete sand (washed), also unwashed concrete sand.	225 tons per hour.	7	Operates intermittently as required. Output used chiefly by asphalt plants.
6- ×48-in. jaw, 7-ft., 5-ft. and 4-ft. Symons cone crushers. Tyrock and Hum-Mer screens. Conical and drag washing equipment.	All standard sizes of sand and gravel (washed) and crushed rock.	1000 tons per hour.	40-45	

Roc
Producer

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMAT SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Consolidated Rock Products Co. (Largo Plant) (Plant 1201 W. Foothill Blvd., Azusa)	28,33	1N	10W	SB proj.	Operated 1909-22 by Pacific Rock & Gravel Co., 1922-29 Union Rock Co., almost continuous since merged with Consolidated in 1929.	San Gabriel River wash; various graniticandmetamorphic rock types.	About 80 acres.	5-yd. electric shovel (steam shovel prior to 1948; diesel shovel prior to 1953.) Hopper feeds primary crusher on pit car on rails. Thence 1100 ft. of conveyor belt to plant.	0.3 mi.×½ mi ×130 ft. (40 50 acres) max
Consolidated Rock Products Co. (Roscoe plant) (Plant 11401 Tuxford, Sun Valley)	18,19, 30	2N	14W	SB proj.	Operated 1909-15 (?) by Tujunga Rock Co.; 1915 (?) -20 (?) by Los Angeles Stone Co., 1920-29 by Consumers Rock Co.; continuous since 1929 merger with Consolidated.	Big Tujunga River wash; various granitic and metamorphic rock types.	1100-ft. wide strip about 1.7 miles long.	5-yd. electric shovel with 2-yd. dragline scarifier in bank above. Hopper feeds primary crusher on pit car on rails. Thence 3500 ft. of conveyor belt to plant.	800 ft.×3500 ft ×120 ft. av
Consolidated Rock Products Co. (Sierra plant) (Plant Peck Rd. at Arrow Hwy.)	2	1S	11W	SB Proj.	Active since mid 1920s. Adjacent pit abandoned 1937, after operated by Blue Diamond Corp.	San Gabriel River wash (Rio Hondo); various graniticandmetamorphic rock types.	About 65 acres.	2½-yd. diesel shovelordragline. 30-ton end-dump trucks haul about ¼ mile to plant.	300 yds. × 75 yds. × 130 ft max.
John M. Ferry Rock Products, P.O. Box 62, Little Rock. (Plant Ave. T and 70th St., East Little Rock)	2	5N	11W	SB	Continuous since opened in 1941 by John M. Ferry Co.	Little Rock wash; various granitic and metamorphic rock types.	320 acres.	Diesel shovel, dragline, clamshell. Trucks haul about ¼ mile to plant.	(various) × 2 ft. (about 2 acres) av.
Graham Bros., Inc., 5500 N. Peck Rd. El Monte	1	1S	11W	SB proj.	Continuous since opened in 1939 by Graham Bros.	San Gabriel River (and Rio Hondo) wash; various granitic and metamorphic rock types. Little clay or overburden.	400 acres.	6-yd. electric shovel. 13-yd. bottom-dump trucks haul as far as 1 mile to plant.	Winter (Ri Hondo): 60 ft. × 1 mi. × 70 ft. av Summer (Sa Gabriel): 40 ft. × 2000 ft ×45 ft. max
Granite Materials Co., Box 559, North Hollywood. (Plant 12455 Wicks St., North Hollywood)	25	2N	15W	SB proj.	Continuous since opened in 1947 by Granite Materials Co. (Former pit 1932(?)-47 immediately north of Blue Diamond Roscoe plant).	Big Tujunga River wash; various granitic and metamorphicrock types. Sand: gravel 70:30 upper 60 ft., 30:70 below 60 ft.	66 acres.	3-yd. diesel shovel, dragline scarifier on bank above. Hopper feeds belt conveyor for 1000-ft. haul to plant.	800 ft. × 900 ft × 150 ft. av

oducts.—Continued.
tive in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
- × 42-in. jaw on rail installation. 10-in. McCully, 4-ft. and 3-ft. Symons cone gyratory crushers. Standard screening and washing equipment.	No. 2, 3, 4, crushed rock. No. 1, 2, 3, 5 gravel. Concrete sand, larger sizes by contract.	350 tons per hour.	22	Pipe water for 1 mi. from well in wash. Minor amount of placer gold recovered as by-product.
× 42-in. and 28 × 36-in. jaw, 7-ft. and 4-ft. Symons cone crushers. Svmons and Tyrock mechanical screens. Sand wheel type washer.	15 standard sizes of crushed rock, gravel, and sand; washed and unwashed concrete and plaster sand.	800 tons per hour.	Production:54	500-ft. well provides water.
- × 30-in. jaw, 36- × 8-in. jaw, 4-ft. and 2-ft. Symons cone crushers. Standard screening and washing equipment.	Concrete sand, No. 2, and pea gravel; No. 3, 4 crushed rock and crusher dust. Special sizes when ordered.	225 tons per hour.	Production:13	
× 36 jaw, 4-ft. and 2-ft. Symons cone crushers. Standard screening and washing equipment.	All standard commercial sizes of sand and gravel (washed) and crushed rock.	200 tons per hour.	Total: 15-18	Water from own well. Deposit bottoms in unsuitable decomposed granite and granitic bedrock below 20 ft.
- × 36-in. jaw. 3-ft. 4-ft. and 5½-ft. Symons, 322R AC, and Telsmith gyratory crushers. Robins and Stephens-Adamson screens; standard washing processes.	All standard commercial sizes of sand and gravel, (washed) and crushed rock, 4-12-in. channel-lining cobbles.	1000 tons per hour.	Production:40	Deep drill holes indicate no change in character of deposit well below practical depth limit.
- × 36-in. jaw, AC gyratory crushers, Stephens-Adamson screens. Standard washing equipment.	Concrete plaster sand; two sizes gravel (washed). Four sizes crushed rock.	400 tons per hour.	Plant: 11 Total: 58	Water from city supply. Blend sand-gravel proportion as desired by scarifying upper or lower part of bank.

Rock
Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Lindauer Corp. Box 337, La Habra	32,33	2S	10W	SB proj.	Opened 1890; continuous since 1921 by Lindauer Corp.	Pleistocene nonmarine sand of La Habra formation. Clean unconsolidated, feldspathic sand of granitic origin, dipping about 20° S.	18 acres.	Diesel shovels. Trucks haul about 300 yds. to plant.	500 ft. × 700 ft. ×120 ft. max.
Livingston Rock & Gravel Co., Inc., 3366 Cherry Ave., Long Beach 7 (Plant 6353 N. Irwindale, Azusa)	32	1N	10W	SB proj.	Opened 1920s (Builders' Crushed Rock Products Co.) active to 1927 (?). Active since reopened 1949 by Livingston Co.	San Gabriel River wash; various granitic and metamorphic rock types.	40 acres.	2½-yd. diesel shovel, 18- and 30-ton end-and-bottom-dump trucks haul about ¼ mile to plant.	350 yds. × 600 yds. × 55 ft. (18-20 acres) av.
MacArthur & Son P.O. Box 82, Palmdale	18	4N	14W	SB	Continuously since opened in 1948 by Mac Arthur & Son.	Santa Clara River bed; various metamorphic and granitic rock types.		Bulldozer. Bulldozer moves material to bucket elevator. Entire plant in canyon bottom.	(Various) 30 ft. (several acres) max.
Manning Bros. Rock & Sand Co. P.O. Box C, Irwindale (Plant 16158 E. Central Ave., Irwindale)	9	1S	10W	SB proj.	Opened about 1930. Continuous since 1937 by Manning Bros. Co.	San Gabriel River wash; various granitic and metamorphic rock types.	57 acres.	2-yd. diesel shovel. 16-yd. bottom-dump trucks haul about ¼ mile to primary crusher. Belt conveyor hauls several thousand feet to plant.	350 yds. × 500 yds. × 200 ft. max.
Osborn Co. 3200 Edgecliff Lane, Pasadena 8 (Plant 2900 Woodlyn Rd., Pasadena)	13,24	1N	12W	SB proj.	Operated 1922-26 (Preston Rock Co.); 1926-41 (Ducey & Atwood); 1941-44 idle. Continuous since 1944 by Osborn Co.	Eaton Canyon wash; various granitic and metamorphic rock types. Some clay and topsoil overburden.	About 90 acres	2-yd. diesel shovel. 17-yd. side-dump trucks haul ¼-¾ mile to plant.	300 ft.×1000 ft. × 50 ft. av. (also several old pits).
Owl Rock Products Co., P.O. Box 187, Monrovia (Plant Longden and Arrow Highway)	1, 2	1S	11W	SB proj.	Continuous since 1936 (?) by Owl Co.	San Gabriel River wash; various granitic and metamorphic rock types.		2½-yd. diesel shovel. 20-ton bottom-dump trucks haul about ¼ mile to primary crusher; conveyor belt to mill.	

roducts.—Continued.
ctive in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
No crushing required. Standard screening and washing equipment. Oil-fired drying kiln.	Six sizes of plaster and concrete sand smaller than ¼ inch; kiln-dried sand.	About 350 tons per hour. (200,000 tons per year).	Total: 13	Sand zone reported 1600 ft. deep.
32- × 40-in. jaw, 4¼-, 4-, 3-ft. cone crushers. Standard screening, washing equipment.	All commercial sizes of sand and gravel (washed) and crushed rock.	450 tons per hour.	Total: 50	450-ft. water well entirely in gravel.
Standard crushing, screening, and washing equipment.	Standard grades of sand and gravel.	About 50 tons per nour.	5	
15- × 30-in. jaw, 3-ft. Symons cone and other crushers. Standard screening and washing process.	All standard commercial sizes of sand and gravel (washed) and crushed rock.	125 tons per hour.	Total: 50	
27- × 36-in. jaw, gyratory crushers. Standard screening washing equipment.	Standard commercial grades of sand and gravel (washed), and crushed rock.	250 tons per hour.	Production:8	
25- × 40-in. jaw. Traylor, cone gyratory crushers. Standard screening and washing equipment.	All standard sizes of sand and gravel (washed) and crushed rock.		Total: about 60	

Rock Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Pacific Rock & Gravel Co. P.O. Box 30, Monrovia (Plant, office 400 Arrow Highway)	1	1S	11W	SB proj.	Continuous since 1935.	San Gabriel River wash; various granitic and metamorphic rock types.	110 acres.	2½-yd. diesel shovel (1938-48 used 8⅓-yd. slackline dragline with 1100-ft. radius about king-post), 10-ton end-dump trucks 1000 yds. to hopper. Belt conveyor 150 ft. to primary crusher; 250 ft. farther to plant.	250 yds. × 600 yds. × 150 ft. (about 15 acres) max.
Edward Sidebotham & Sons Inc., 751 E. L St., Wilmington, (Plant 26321 Pennsylvania Ave.)	35	4S	14W	SB proj.	Continuous since 1919.	Pleistocene San Pedro sand, of terrace or beach origin, of granitic parent rocks. Very little larger than 1 in.	About 50 acres.	4-yd. slackline dragline. Dragline hauls about 1000 ft. to plant.	400 ft. × 1000 ft. × 400 ft. max.
Sierra Rock Products Co., P.O. Box 216, Temple City (Plant ¼ mi. East of Peck Road on Arrow Highway.)	1,2	1S	11W	SB proj.	Continuous since 1946, by Sierra Co.	San Gabriel River wash; various granitic and metamorphic rock types.	44 acres.	2½-yd. dragline; 30-ton bottom-dump trucks haul about ¼ mile to plant.	(a) 500 ft. × 750 ft. × 115 ft., (b) 400 ft. × 500 ft. × 115 ft., (c) 300 ft. × 500 ft. × 115 ft.
Torrance Sand & Gravel Co., 25701 Crenshaw Blvd., Torrance	27	4S	14W	SB proj.	Continuous since 1949 by Torrance Co.	Pleistocene San Pedro sand of terrace or beach origin; granitic rock types. 90% concrete sand size, or finer.	119 acres.	Diesel shovel. End-dump trucks haul about 200 yds. to plant.	(various) × 165 ft. (about 20 acres) max.
Transit Mixed Concrete Co., P.O. Box 498, Palmdale (Plant 6851 Avenue T.) (Main office 3424 E. Foothill, P.O. Box 247 East Pasadena)	2	5N	11W	SB	Opened 1948 (Griffin, then Hare Co.). Since 1952 operated by Transit Mixed Co.	Little Rock wash; various granitic and metamorphic rock types.	160 acres.	Bulldozer. Bulldozed to primary crusher.	300 ft. × 600 ft. × 15 ft. av. (also several large older pits).

roducts.—Continued.
ctive in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
AC 6K, 4-ft. gyratory crushers. Standard screening and washing equipment.	All standard sizes sand and gravel (washed) and crushed rock.	350 tons per hour.	Plant: 22	
o crushing. Hum-Mer-screens, Stephens-Adamson sand washer and jig.	Concrete sand and plaster sand, both washed.		Total: 26.	500-ft. water well entirely in sand.
8- × 20-in. jaw, 3-ft. Symons cone crushers. Pioneer screens. Standard washing process.	Mixed concrete and plaster sand (washed); No. 2, 3, 4 crushed rock, sand, and gravel mixed.	170 tons per hour.	Total: 18 (2 shifts).	253-ft. water well entirely in suitable material.
aw crusher (rarely used). Standard screening and washing equipment.	Concrete and plaster sand (washed); pit-run gravel (washed); unwashed bank sand, fill dirt, topsoil, field rock, crushed rock.	About 100 tons per hour.	Total; 10.	600-ft. well; gravel unchanged to 385-ft. depth.
5- × 36-in. jaw. 36-in. crushing rolls. Standard screening and washing equipment. (Under construction and expansion in 1952.)	Plaster and concrete sand, No. 2, 3, and 4 gravel-crushed rock mix, all washed.	50 tons per hour.	5	Water from well. Deposit bottoms in decomposed granite and bedrock below about 15-ft. depth. Plant under construction in 1952.

Rock
Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Decomposed Granite Crushed Stone									
L. A. Decomposed Granite Co., Box 39, Montebello	2	2S	12W	SB proj.	Active under present management since opened in 1927 (?)	Pleistocene La Habra conglomerate. Unsorted, unconsolidated granitic debris as large as 1 ft. diameter with much sand. Largely decomposed, gently south dipping.	Over 50 acres	Air drills, blasting, 1-yd. and 1¼-yd. gasoline shovels. Portable plant at quarry face.	Upper active pit: 200 ft. × 800 ft. × 35 ft. av. Lower, abandoned pit: 300 ft. × 1000 ft. × 40 ft. av.
McCaslin Materials Co., 450 Potrero Grande Dr., Monterey Park	35	1S	12W	SB proj.	Opened in 1942; present owners continuously active since 1945.	Pleistocene La Habra conglomerate. Unsorted, unconsolidated silt, sand, cobbles as large as 1 ft. diameter. Granitic igneous and metamorphic rock types partially decomposed.	60 acres.	Bulldozer, carryall, supply material to main mill; ¾-yd. gasoline shovel feeds portable mill when in use.	¼ mile max. (no haulage to portable crushing plant) 100 yds. × 300 yds. × 30 ft. av.
Monterey Park Granite Co., Inc., 1310 S. Garfield Ave., Monterey Park	27,34	1S	12W	SB	Opened in 1944 (?) by B. O. Kiger Co., present operators continuously active since 1947.	Pleistocene La Habra decomposed unsorted, unconsolidated sandy conglomerate with gravel and clay present. Granitic rock types.	80 acres.	¾-yd. diesel shovel loads trucks directly (late 1952). Previously bulldozer supplied material to portable crusher.	No haulage to portable crushing plant. 100 yds. × 300 yds. × 30 ft. max. (abandoned excavation as deep as 90 ft.)
Mulholland DG Co., 5032 Lankershim Blvd., North Hollywood	35	1N	16W	SB proj.	Opened 1951; present operators active in 1952. (Inactive in January 1953.)	Decomposed Jurassic (?) granitic rock.	Flexible lease within about 12,000 acres of separated granitic exposures.	1-yd. gasoline skip-loader, bulldozer. 100 ft. maximum.	50 ft. × 100 ft. × 25 ft. max.
Owl Rock Products Co., P.O. Box 187, Monrovia	36	1S	12W	SB proj.					

oducts.—Continued.
tive in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
× 38-in. jaw crusher, vibrating screens in portable plant.	Decomposed granite for road construction.	175 tons per hour.	5	Lower pit abandoned because of excessive clay. No stock-pile; crushing plant loads trucks directly for delivery.
ain plant: Hammer mill crusher, mechanical screens. Portable plant: Grizzly, hammer mill, mechanical screens.	Decomposed granite for road base material, underslab. Parking lots. 1⅜″ maximum size.	100 tons per hour (portable) 400 tons per hr.-max. (main plant).	4	Portable and main plant used alternately, depending on weather.
t-run material: no processing (load trucks direct for delivery) 8- × 15-in. jaw crusher used when crushing required.	Decomposed granite crushed less than 3 in. diameter usually. Pit-run, not crushed, used for black top.	About 200 tons per hr. max.	4	Land-leveling project for housing development. Material with more sand, fewer large cobbles, used directly for black top without crushing.
w crusher, mechanical screens on portable machine.	Decomposed granite (DG) generally less than 2 in. diameter, used on street, parking lots.	About 50 tons per hr. max.	2	No data released for publication.

Rock Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Broken and Crushed Stone									
Connolly-Pacific Co., 1925 Water St., Long Beach 2 (Pebbly Beach quarry, Santa Catalina Island)	11(?)	10S	14W	SB proj.	Active intermittently since 1934 by Case-Connolly (Connolly-Pacific.).	Compact metamorphosed conglomerate and graywacke.	200 acres leased.	After coyote-hole blasting 2½-yd. diesel shovels load 15-yd. trucks which dump into steel skips. 30-ton crane unloads skips on barges for towing to mainland. Largest stone moved in slings. ½ mile average haul to barge.	150-200 ft. × 1200 ft. × 200-500 ft. working face on bench in steep hillside.
Graham Brothers, 5500 N. Peck Rd., El Monte (Empire quarry, Santa Catalina Island)	29(?)	8S	15W	SB proj.	Continuously active since opened by Graham Bros. in 1949.	Partly decomposed dioritic rocks.	100 acres leased.	2½-yd., 1½-yd. diesel shovels 6-yd., 3-yd. Walking Monighans, 8-ton end dump trucks for hauling several hundred feet to grizzly and crusher. Walking Monighan loads barge for transport to mainland.	Working face several hundred feet high on bench cut in steep hillside.
Livingston Rock & Gravel Co. Palos Verdes Crushed Rock. 3366 Cherry Ave., Long Beach (Plant in Palos Verdes Hills)	9,16	5S	14W	SB proj.	Operated at various times for many years by different companies. Livingston active since 1948.	Altered Miocene basalt and minor sediments, including dolomitic rock and shale.		2½-yd. diesel shovel loads trucks for ¼-½-mile haul to plant. After crushing, 10-yd. trucks haul 4½ miles to barges for transport to harbor area.	500 ft. × several thousand ft. × 100 ft. max. (a series of adjacent excavations.)
Foundry Sands									
Caswell & Co. 2357 E. Slauson, Los Angeles (Two pits: No. 77 and No. 99)	4 (77) 5 (99)	4S 4S	14W 14W	SB proj. SB proj.	Active about 15 years.	Flat-lying Quaternary alluvium. 4 ft. of overburden overlies 6 ft. of dark reddish-brown naturally bonded silica sand which overlies clay-free sand.	8 acres, 10-26 acres.	Power shovel loads trucks for haul to mill near the 77 pit.	About 4½ acres 15 ft. av. About 4 acres 30 ft. max.

products.—Continued.
active in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
No crushing or screening.	A-rock: 1 to 10 tons mixed, (as large as 35 tons). B-rock: 20 lbs. to 2 tons C-rock: fines to ½ ton for piers, breakwaters, etc.	1800-2000 tons per shift.	18-20	Used for piers, breakwaters, etc., in Los Angeles, San Pedro, and Long Beach harbors.
- × 36-in. jaw, 40-in. rolls crushers used as required. Classification into size categories by grizzlies. No screens.	A-rock: 2-15 tons; Rip-rap: 2 tons-12-in.; 12-in. to 6-in. stone. Crusher-run base (minus 2-in.)	250 tons per hour.	20	Wagon drill, primary blasting used occasionally. Used for road-base, fill for subsidence areas, rip-rap, breakwater.
0 × 42-in. jaw, 54 × 42-in. and 42 × 22-in. roll crushers: mechanical screens.	Crusher run base: fines to 1 in.; 1-in. to 3-in. crushed stone for fill base, etc., Largest is 6″ rock.		About 15 (2 shifts).	Blasting by 30-ft. holes in 60-ft. benches. Selection of rock from different parts of quarry to meet requirements.
umps broken on rolls and screening: (mulling); mixed to meet various specifications.	No. 77 molding sand, U-77 core sand, No. 99 molding sand, U-99 core sand.	50 tons per hour (mill).		Encroaching housing developments threaten to close pits.

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Lawrence I. Liston Co., 4053 W. 169th St., Lawndale	9, 10	4S	14W	SB proj.	Active since early 1930s, exhausting several pits.	Fine-grained flat-lying Quaternary alluvium. Several inches of overburden cover 15-20 ft. or more of uniform light buff crudely stratified sand (Madrona), reddish-brown massive sandstone, 10-20 ft. face exposed. Grades to lighter brown stratified sand and siltstone. (Redondo Beach Blvd.)	Total about 50 acres.	Power shovel loads trucks for haul (average 5 miles) to mill in Lawndale.	
Miller Bros. Truck Co. O.-E. and R. G. Miller, 3451 Randolph St., Huntington Park (Two pits: Vollmer and Hawthorne)	32 Vollmer pit. 16 Hawthorne pit.	3S 4S	14W 14W	SB proj. SB proj.	Active since 1937 (No. 7). Active since 1949 (No. 15).	Three feet of overburden cover 12-ft. layer of heavy moulding sand. (No. 7.)	Several acres (No. 7).	Bulldozers and power shovels load trucks for haul to mill.	Several acres × 12 ft. av.
Quartz Hill S. L. Gillan 230 Webb Dr., Glendale	20	2N	13W	SB proj.	Active from 1918 to 1949.	Nearly pure quartzitic silica rock in igneous and metamorphic terrane. Highly fractured.	11 acres total. 4½ acres of silica rock.	Electric shovel loaded trucks for 10-12 mile haul to mill. (Blasting not required.)	
Westlake & Sons, 5210 Templeton St., Los Angeles	9 (active) 16 (abnd)	1S 1S	13W 13W	SB proj. SB proj.	Active since 1948. Active 1919-48.	Trough-like alluvial fill overlying Pliocene sandstone. Flat-lying silty, medium-grained sand overlain by several feet of soil and clay.	Several 50 ft. × 100 ft. city lots.	Spear-Wells spiral screw loader fills trucks for haul direct to foundries.	50 ft. × 75 ft. × 20 ft. max.

products.—Continued.
active in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
Roll crushers remove lumps. No screening. Mix to required specifications.	D5 heavy molding sand (Blood Co.); Madrona No. 1 and No. 2, and other mixtures as specified.	30 tons per hour (mill).	5-7	Mine and prepare foundry sand to specifications of dealers (Harry E. Blood Co. and Brumley Donaldson Co.)
Roll crushers remove lumps. Blended to meet specifications.	No. 7 heavy molding sands, No. 15 medium molding sand.	About 20 tons per day.		Also blend sands from Ventura and Riverside Counties, and Nevada.
aw and roll crushers, mechanical screens. (Product between 10 and 40 mesh screens.)	Core sand for large steel castings; small amount for silica brick.		6 max.	Solid silica rock, not a sand or sandstone. Distributed by National Supply Co., Torrance. Product ran 98% silica, 1.5% alumina, 0.5% iron oxide.
o crushing except by hand tools and screw loader.	Heavy molding sand used chiefly in heavy gray iron castings and soil pipe.		4	Upon depletion of deposit in Elysian Park, commenced excavating successive lots, reducing slopes to level for building purposes.

Rock Producers

NAME, OPERATOR	LOCATION				HISTORY OF OPERATION	GEOLOGICAL DATA	MINING DATA		APPROXIMATE SIZE OF EXCAVATION
	Sec.	T	R	B&M		Type of deposit	Holding	Equipment and haulage	Width Length Depth
Locomotive Sand									
Walter D. Ransom, 3467 Greenfield Ave., Los Angeles	13,14	3S	15W	SB proj.	Active from 1931 to 1947 as Leibee Engineering Co. Ransom active continuously since 1947.	Beach sand dunes.	5 acres.	Bulldozer feeds bucket elevator for loading trucks to haul to track where high loaders fill railroad cars.	100 ft. × 100 ft. × 30 ft. max.
Sandblasting Sand									
Gordon Transfer & Trucking Co., 907 Main St., El Segundo	11	3S	15W	SB proj.	Active since 1927, but on small scale prior to 1938.	Beach dunes; fine quartzose sand with minor amounts of feldspar and heavy minerals.	6 acres.	Case skip loaders fill trucks directly for delivery.	150 ft. × 300 ft. × 60 ft. max. (Main pit) 75 ft. × 200 ft. × 50 ft. max. (No. 2 pit).
McIlroy Blasting Sand Co., 745 W. Mariposa Ave., El Segundo	11	3S	15W	SB proj.	Active since 1944.	Beach dunes; fine-grained quartzose sand with small amounts of feldspar and heavy minerals.	Several acres.	Skip loader fills trucks for haul to plant.	100 ft. max. × 300 ft. × 30 ft. max.
Paramount Sand Co., 1617 El Segundo Blvd., El Segundo	11	3S	15W	SB proj.	Active since 1946.	Beach dunes; fine-grained quartz sand with small amounts of feldspar and heavy minerals.	Several acres.	Skip loader fills 8-ton dump truck for 1-mile haul to plant.	100 ft. × 200 ft. × 60 ft. max.
Miscellaneous Specialty Products									
Consolidated Rock Products Co., (Irwindale No. 7 plant) Box 2950, Terminal Annex, Los Angeles 54 (Plant at 4829 Irwindale Ave., Irwindale)	8, 9	1S	10W	SB proj.	Active continuously since 1944.	Raw material is washed sands and gravels produced in Irwindale No. 6 plant adjacent.		See Consolidated Rock Products Co., Irwindale No. 6 plant, above.	

products.—Continued.
active in 1952.

PROCESSING DATA				REMARKS
Crushing, classification, washing	Products	Reported capacity	Number of employees	
No treatment whatsoever.	Locomotive sand. Minor amount of foundry sand.	300 tons per day.	3	Grading land for Standard Oil Co. Natural dune sand meets size requirements without any processing.
No crushing, screening, washing or drying.	Blasting sand for house, industrial sandblasting. Minor amounts of foundry sand, sweeping compound sand.	20,000 tons per year.	4 truckers. 1 pit man.	Increase in sandblasting of house exteriors increased demand greatly since 1938. Foundry sand untreated.
Screen through ½-in. mesh, dry in rotary kiln.	Blasting sand, coarse for structural steel, houses; fine for autos, airplanes. Playground sand. Small production for foundries, sweeping compound.	120 tons per day.	3 in pit, plant.	Drying and screening plant being moved to new location in January 1953. Foundry sand untreated.
Screen out foreign matter, dry in rotary kiln.	Blasting sand for house and industrial sandblasting. Minor production of foundry sand.		6 total	Foundry sand untreated.
All material kiln dried prior to dry-screen separation. Rescreen material to various specified size ranges. 16-in. by 18-in. roll crusher used occasionally. No washing or air classifying.	Roofing gravel; roofing granules (crushed); blasting sand; filter gravel; locomotive sand; poultry grit; filler dust; terrazo granules; pipe-coating sand; various specialty sands as ordered.	Varies with material.	6 (24-hr. operation).	Largest material handled is 1½-in., but nearly all is smaller than ½-in. Plant produces only one product at a time. Largest demand is from roofing industry.

Miscellaneous Rock Products

Chinchilla Dust. A phase of the rock products industry new to Los Angeles County in 1950 is the production of chinchilla dust. Only one deposit in the county, the Blue Cloud deposit, is being mined exclusively for this purpose. Chinchillas bathe in fine dust, rather than in water, and the nature of the dust is of great importance to the animals and to the chinchilla fur industry. Preparations of fuller's earth, talc, sand, and ground volcanic ash are used. To be desirable for chinchilla dust, material should, when pulverized, have a blue-gray color complimentary to fine pelts, be highly absorptive of oil and moisture, be mildly abrasive but not injurious to fur, be inert chemically and contain no lime, and be pleasing to the chinchillas themselves.*

The Blue Cloud deposit is in a stratum of altered tuffaceous sediment at least 6 feet thick that strikes N. 60° W., dips 30° SW. and lies between sandstones of the upper Miocene Mint Canyon formation. The material being mined is rather blocky, porous, and has a uniform gray color. The stratum can be traced laterally for more than half a mile.

The material is mined in an open pit with a face that was about 25 feet high and 40 feet long in 1952. The overburden is stripped by bulldozer and the material is blasted and then removed with crowbars and hand tools. Careful sorting is necessary to avoid contamination with overburden. Broken material is moved to a nearby mill in wheelbarrows.

In 1952 a mill at Newhall which had been treating material from this deposit since 1950 was dismantled and set up at the deposit. In this mill the material is pulverized in a roll crusher and hammer mill, passed through vibrating screens, dried in a rotating gas-fired kiln, and sacked in 50-pound bags for shipment. The finished material contains particles distributed in size between 20- and 200-mesh thus preventing the dust from being either too light or too heavy. Sizes and tilts of the screens are adjusted to maintain desired particle size distribution in the product. In the 600° F. temperature of the kiln, moisture is removed and the dust is sterilized.

Early in 1953 a production rate of about 50 tons a month was maintained. The sacked dust is distributed throughout the United States and even exported. The market is limited because a pen of one to four chinchillas generally requires less than 25 pounds of dust a year.

Diatomaceous Shale. Since 1950 diatomaceous shale has been produced from upper Miocene strata of the Modelo formation. About a thousand tons per year has come from an open pit about 100 feet square in the east side of Schwartz Canyon. The material is milled in the Los Angeles area and used for insecticide carrier.

Volcanic Ash. Volcanic ash, in part altered to clay, was mined from upper Miocene beds of the Mint Canyon formation in Sand Canyon from 1937 to 1940. A total of several thousand tons was reported mined from a series of shallow open pits distributed over an area several hundred yards long and several hundred feet wide. The material is said to have been processed in Los Angeles, and used in the roofing industry.†

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* Harris, C. W., Personal communication, 1953.
† Walker, F. E., Personal communication, 1951.

"Volcanic Rock" (Burned Shale). Naturally burned Miocene shale has been produced in Las Virgenes Canyon and sold under the name "volcanic rock" (see tabulated index).

Sand, Gravel, and Crushed Rock

War-time and post-war expansion of heavy construction industries have greatly increased the demand for sand, gravel and crushed rock for concrete aggregate. Buildings, highways, bridges, flood control dams and canals, and harbor projects account for the bulk of aggregate used.

Geology of the Deposits. Materials for the sand, gravel and crushed rock industry are obtained mainly from alluvial deposits in the dry washes of the San Gabriel River in San Gabriel Valley, and the Big Tujunga River in San Fernando Valley. These deposits are similar in most respects, and consist of stream-laid detritus from the San Gabriel Mountains. They were deposited mostly by floods. Loss of volume of water and flattening of the stream gradient cause the floodwaters to lose their carrying power and to deposit the debris along the stream courses. Gradual shifting of channels caused distribution of deposits over areas thousands of yards wide and miles long. Operating repeatedly from late Tertiary time to the present, this process has resulted in deposits many hundreds of feet thick.

In general, the deposits are progressively less coarse outward from the mountain front. A high proportion of large boulders in the deposits nearest the mountains is a hindrance to operations.

The deposits generally show crude horizontal stratification but are poorly sorted. Thin layers notably rich in silt, sand, or boulders, are, however, found throughout the range of depth of the pits. In the Big Tujunga Wash sand predominates in the uppermost 40 to 60 feet of most quarries whereas gravel and coarser material are most abundant below this level. About one percent of the material mined in either river wash passes a 200-mesh screen.

Rock types present in the deposits include various igneous and metamorphic types. Most of the fragments are gneissic. The rocks range in composition from true granite to gabbro with quartz diorite and diorite gneiss most abundant. Small percentages of basic dike rock fragments are present, as are quartz or alaskite fragments. The sand fraction of the deposits is highly feldspathic, but contains a large proportion of quartz as well as minor fractions of the heavy minerals ilmenite-magnetite, zircon, garnet, epidote, sphene, and apatite, and traces of gold. In both areas this lithology persists downward for at least 500 feet, the depth of the deepest water wells.

At depth the strength of the coarse fragments decreases somewhat. Abrasion tests show material from the surface to a depth of 45 feet to be appreciably stronger than material from the 85- to 125-foot range. In one pit in the Big Tujunga Wash a marked decrease in strength is noted for material below 135 feet in depth. The decreased strength of the deeper material is apparently caused by its having been subjected to the weathering action of ground waters for a longer period. It is noted that specimens of well-foliated rock with a large amount of mica were among the most disintegrated rocks. The largest, most resistant boulders are almost invariably of white diorite with a minimum of aligned ferromagnesian minerals.

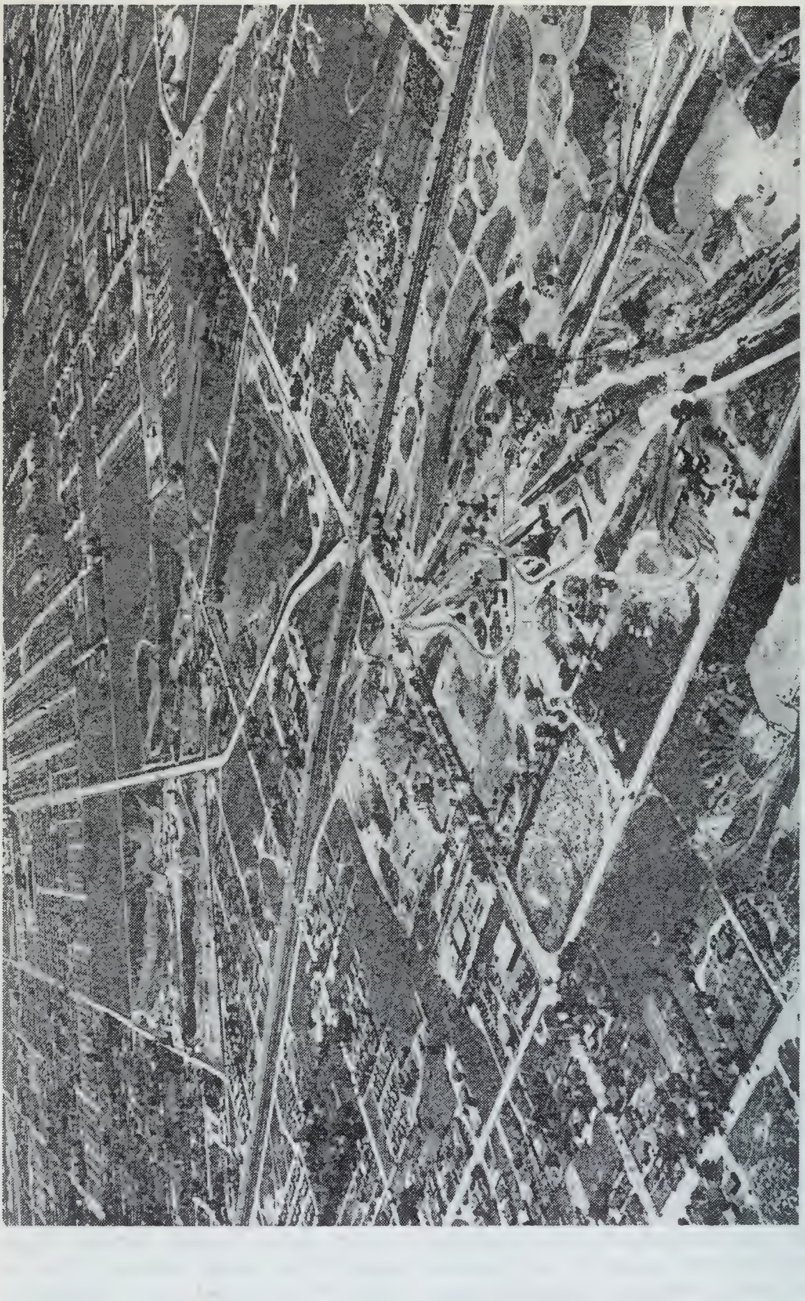

FIGURE 10. Aerial view south toward intersection of Tuxford Street, Tujunga Avenue, and San Fernando Road, showing sand and gravel pits. *Spence Air Photos, Los Angeles, 1951.*

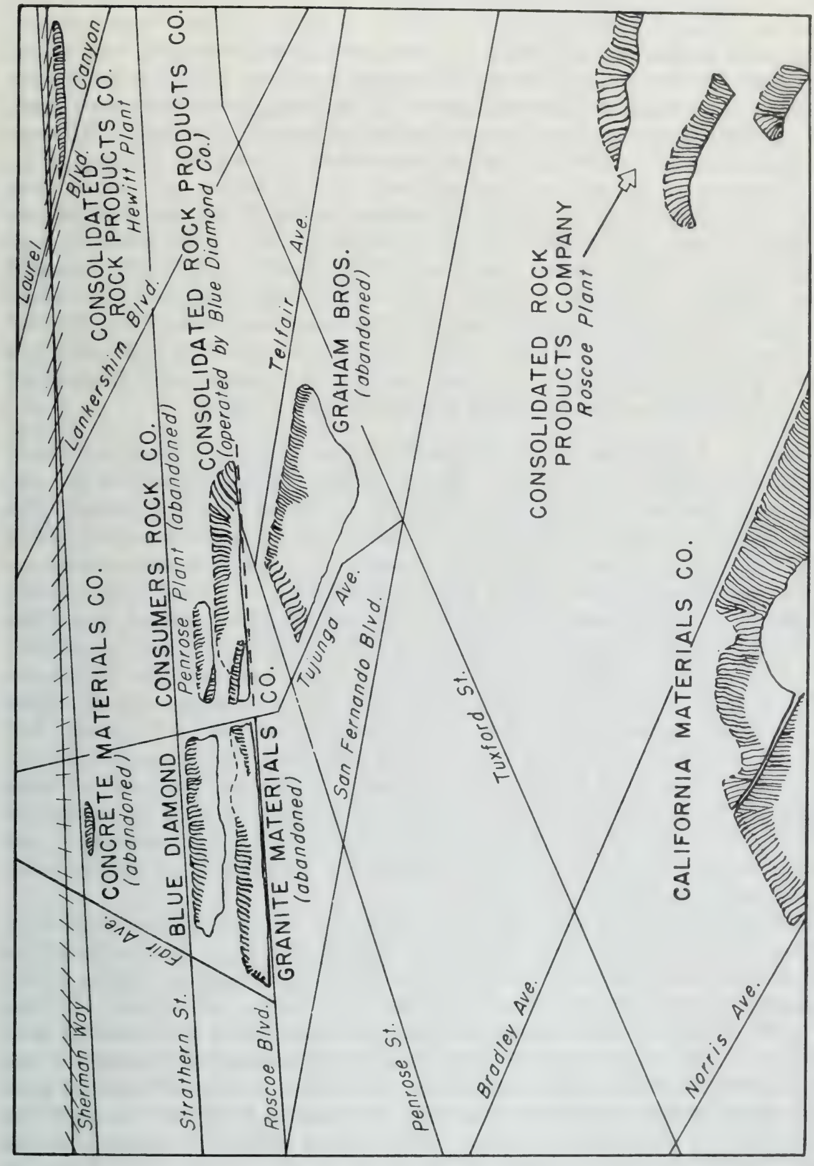

FIGURE 11. Sand and gravel pits in San Fernando Valley.

Alluvial gravel for use as aggregate is also mined on the north side of the San Gabriel Mountains in a dry wash near Little Rock in Antelope Valley. The deposit is similar in most respects to the larger ones just discussed, except that the alluvium rests on decomposed granitic rock 15 to 20 feet below the surface.

In the Palos Verdes Hills and the Puente Hills steeply tilted Pleistocene nonmarine deposits of sand and gravel are also sources of aggregate. In the Palos Verdes Hills sand and gravel are mined from the San Pedro sand and terrace cover (Woodring, Bramlette, and Kew, 1946, p. 120) adjacent in places to diatomite beds of the upper Miocene Valmonte member. The La Habra formation (Kundert, 1952, p. 11), also Pleistocene in age and considered a correlative of the terrace cover (Wissler, 1943), yields aggregate material of similar nature (Kundert, 1943, pp. 21-22). These deposits contain poorly sorted material almost entirely in the size range of sand, with very little material coarse enough to yield crushed rock. The rock fragments in these deposits are generally granitic, similar to those nearer the San Gabriel Mountains. The sand is well stratified although uplift of the areas has steeply tilted the strata. Deep well drilling indicates that commercial material extends several hundred feet below the surface.

Zoning. A problem facing the industry in the next decade is that of maintaining adequate reserves. Many square miles underlain by undeveloped alluvial deposits are adjacent to present operations in both the San Gabriel and Big Tujunga Washes but these areas are rapidly being covered with residential and commercial buildings and roads.

City and county zones have been established in recognition of the problem of multiple use of the land. On county lands, which are principally in the San Gabriel area there exists only one "Q" (quarry) zone, and additional pits may be opened within it as desired. This zone, which is near Duarte, is a little over 100 acres in area. On all other county lands present pits may be worked to established limits, but special permits must be obtained before any new ones may be started. The County Regional Planning Commission rules on requests for such permits after considering such factors as flood control and the status of subdivision in the area. Interests of the County Road Commission, the Air Pollution Control Board, and others are considered at public hearings on each request for rezoning.

Individual cities control the establishment of pits within their corporate limits. In the San Fernando Valley the city of Los Angeles controls much of the unmined portion of the Big Tujunga Wash. A city ordinance * provides for the establishment of rock and gravel districts to "provide for a more economic production of rock and gravel, and which will also take into consideration the value and character of the existing improvements within three hundred feet of districts where such production is hereinafter premitted, the desirability of the area for residential or other uses, or any other factor directly relating to the public health, comfort, safety, and general welfare in rock and gravel districts." For purposes of this ordinance the expression "rock and gravel" includes any rock, sand, gravel, aggregate, or clay. Presently operating pits constitute rock and gravel districts, but application must be made to the City Planning Commission to have additional land desig-

* Los Angeles City ordinance, no. 92,679, sec. 13.03.

nated for this use. Hearings and considerations are similar to those for county lands, above.

Restrictions are imposed by the city of Los Angeles on operations within city rock and gravel districts. These regulations aim at elimination of noise, vibration, or dust; restriction of operation within 50 feet of property lines without permission of the adjacent owner; limitation of slopes of open pits steeper than 100 percent grade (45° slope); enclosure of pits within fences where practicable; restoration of abandoned land; restriction of operating hours between 6:00 A.M. and 8:00 P.M.; and requirement of adequate insurance coverage by operators.

Reserves. When additional surface area in the presently active areas is no longer available for expansion of the industry, the remaining possibilities are to dig deeper pits or to discover new deposits farther from urban areas. If deeper pits are to supply the future needs of the industry specifications or processing techniques may have to be modified in consideration of the decomposed state of the deeper gravel. Mining techniques will have to take into account the greater depths and steeper hauls. Additional problems will arise where deeper quarrying will be largely below the water table. Although underwater sand and gravel pits are common in other parts of the state, there are no underwater operations in this county. Fine-grained rock particles tend to be largely left behind in the water in the pit during underwater excavation, causing an undesirable deficiency of fines in the product. Machinery for underwater mining may be somewhat different from much of that in present use. Far-sighted operators are already considering the use of such equipment as floating dredges, bucket-line excavators, pump-line conveying, and floating processing plants to operate within deep pits.

In 1952 the deepest mining was at about 150 feet. Several pits have been mined to about 200-foot depth, but were flooded and inaccessible in their deeper levels because of the high water table in 1952. Fluctuations of as much as 30 feet in the ground-water level occur seasonally, and are largely dependent on periodic release of water from flood-control dams. Water intentionally released from flood-control dams has an immediate and often considerable effect on the water table at nearby pits. Sudden floods have the same effect as a rising water table in forcing rapid withdrawal of equipment from deep pits to avoid water damage. One operator excavates a deep pit in the San Gabriel Wash in summer and a shallower one in the Rio Hondo Wash in winter to avoid threat of water damage.

Specifications. The earliest aggregate products were sized according to the type of raw material and equipment at hand and the desires of consumers. For many years specifications grew in number and complexity as different engineers and concrete technologists specified original mixes for particular uses. It has been stated (Lowe, 1949) that at one time in order to supply all of the various sizes of aggregate that might be specified, a plant would have had to produce as many as 30 or more different sizes of aggregates. Through the efforts of producers and their associations, in cooperation with designing engineers, specifications have been standardized and reduced in number in recent years. County, state, and U. S. Army engineers have been instrumental in

developing suitable specifications for aggregate to be used in public works projects.

Aggregate is classified into three major categories: sand, gravel, and crushed rock, according to size and type of particle. Raw material smaller than about $2\frac{1}{2}$ inches is screened and washed to produce sand and gravel, whereas fragments larger than this are crushed and screened to produce crushed rock. All rock and gravel must be clean, hard, sound and durable, of uniform quality, and free of any detrimental quantity of soft, friable, thin, elongated or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious or reactive substance. Also of importance are specific gravity, resistance to abrasion, and proportion of naturally rounded surfaces compared to freshly broken surfaces. Maximum and minimum sizes are very closely prescribed as well as particle-size distribution within the size ranges. Washing is required for virtually all concrete and plaster sand, and gravel, but not for crushed rock. Washing is desirable for the removal of colloidal matter but is not beneficial if too great a percentage of fine particles is removed. Materials such as stone dust or sand for use in asphaltic concrete and pre-mix paving mixtures have individual specifications. Specialty products such as roofing gravel or granules, filter gravel, nursery gravel, sand-blasting sand, locomotive sand, poultry grits, pipe-coating sand, terrazo granules, sand-trap sand, and filler dust are produced to the specifications of the consumer. Thousands of tons of cobbles, 4 to 12 inches in diameter, are produced for facing of flood-control dams.

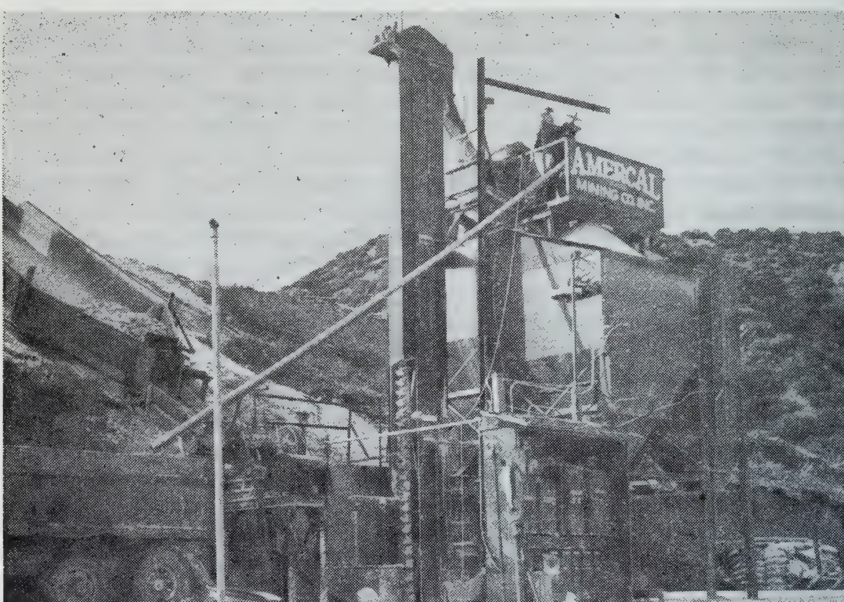

FIGURE 12. Roofing-granule plant of Amercal Mining Company; view northwest.

Nominal size specifications of the main classes of aggregate produced by the majority of companies in Los Angeles County are shown in table (Lowe, 1949, p. 1)*. Lesser quantities of other sizes of crushed rock, crusher dust, asphalt and mortar sand, and mixtures of sizes, are also produced.

Nominal size specifications of the main classes of aggregate produced by most companies in Los Angeles County.

Crushed rock (not washed)	
No. 1 crushed rock	3½″ to 1½″
No. 2 crushed rock	1½″ to ¾″
No. 3 crushed rock, large	1″ to ½″
No. 3 crushed rock, small	¾″ to ⅜″
No. 4 crushed rock	⅜″ to No. 6
Gravel (washed)	
No. 1 gravel	2½″ to 1½″
No. 2 gravel	1½″ to ¾″
No. 3 gravel	1″ to ⅜″
No. 4 gravel (pea)	⅜″ to No. 4
Sand (washed)	
Concrete sand	No. 4 to 0
Plaster sand	⅛″ to 0

Operations. Production of crushed rock, sand, and gravel, consists essentially of mining the raw material, and then crushing, washing, and classifying it according to size in a processing plant. Summarized data on all operations known by the writer to have yielded rock products in Los Angeles County appear in the accompanying table, and in the tabulated index of this report. A generalized description of the methods in use by the different operators in the county follows.

Mining is entirely in open pits. The working face is mined by diesel or electric powered shovels and draglines with buckets up to 6 yards capacity. In deeper, larger pits a dragline at original ground level lowers and raises a heavy metal scarifier along the face, knocking loosened material below to the shovel. This prevents development of overhanging banks, and increases the efficiency of the shovel by providing a supply of loose material. The scarifier also may selectively mine either coarser or finer material at different levels of the face. Material is loaded into trucks or via feeding hoppers directly onto belt conveyors for the haul to the plant. End-, side- and bottom-dump trucks are used, that have capacities of as much as 30 tons. Haulage may be partly by truck and partly by belt conveyor.

Slackline cable draglines, now in use in the Palos Verdes Hills area, combine the function of mining and hauling as do bulldozers at several operations. The longer belt conveyors are in sections for greater mobility. The longest system of belts now in use in the county totals 4,700 feet of haul. Surge piles are customarily established between sections of conveyors to give reserve stability to the raw material supply. Primary crushing may be done between conveyor sections.

Near the plants, material is generally dumped on a storage pile to be reclaimed, as desired, for processing. A grizzly rejects boulders too large (1½ to 2 feet diameter) for the primary crusher. Belt conveyors,

* Weintz, B. P., Consolidated Rock Products Company, Box 2950, Terminal Annex, Los Angeles 54, California, personal communication, 1952.
Feraud, H. G., Southern California Rock Products Association, 1722 North Eastern Avenue, Los Angeles, California, personal communication, 1952.

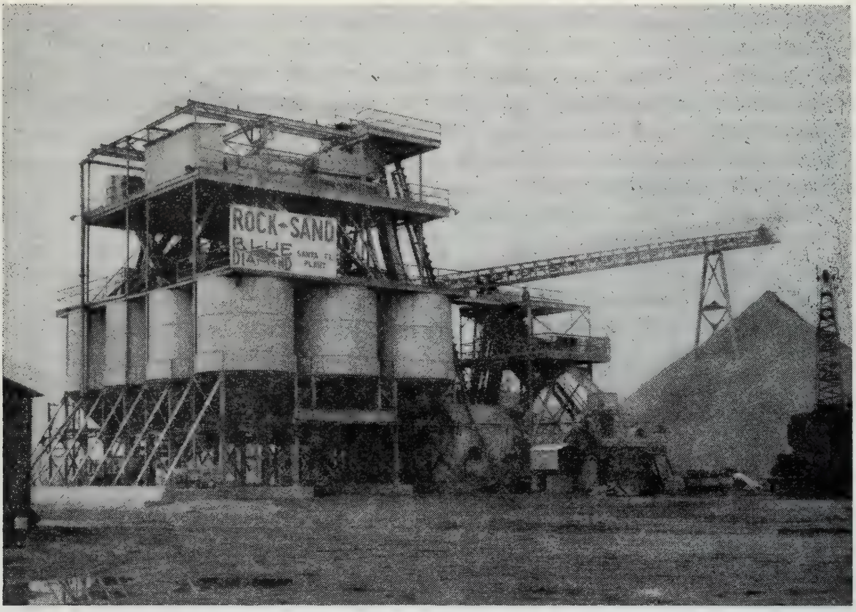

FIGURE 13. Santa Fe sand, gravel, and crushed rock plant of Blue Diamond Company near Azusa. Crushing, screening, washing, and loading functions are combined in this single integrated structure.

bucket elevators, and gravity transport are used to move all material at the plants. Either just before or just after the primary crushing, material is divided into two portions by a scalping screen usually having 2- to 3-inch openings. In several plants trommels are used for scalping. The coarser fraction goes to the crushed rock side of the plant where it is repeatedly crushed and screened as many times as necessary to produce the desired amounts of the various sizes of crushed rock. Several types of single, double, and triple-deck vibrating screens as much as 5 by 14 feet and 6 by 12 feet in surface area are in use. Primary crushing is generally by jaw crushers, as much as 48 by 42 inches in size, set for crushing to about 3 to 5 inches. Secondary crushing is done mostly by gyratory crushers, but rolls and jaw crushers are also used. Crusher settings, screen sizes, and flowsheets are varied to accommodate the average size range of raw material to the desired final products. Crushed rock is not washed.

The fine fraction separated at the scalping screen goes to the sand and gravel side of the plant to be washed and screened into the sizes desired. The separation of sand and gravel into desired size ranges is also accomplished by the use of vibrating screens operating either wet or dry. The sand and gravel fraction is washed but is not crushed. Several standard designs in log, rake, and spiral types of sand-washing equipment are in general use.

Upon leaving the plant the washed sands are stored in heaps on the ground to drain. After drying they are transferred to elevated storage bins or piles. The crushed rock is stored directly in elevated bins or in piles on the ground. The elevated bins suitable for gravity loading of trucks are refilled as necessary by clamshells or belt conveyors from

ground storage piles. Newer plants are notably compact and commonly all processing machinery is located in a single elevated structure under which trucks or railroad cars may move to be loaded.

Most plants obtain water from their own wells, some as deep as 500 feet. Washing operations require a tonnage of water about equal to the tonnage of sand and gravel being washed. The used washing water, carrying colloidal and fine material, is discarded into abandoned pits whence it filters back into the ground-water supply. Minor quantities of water are also used to wet dust and prevent air pollution at the plants, and on loaded trucks to prevent excessive dust escape during hauling.

One of the major problems of the producer is in foreseeing demand so as not to run short of sizes in demand or to tie up storage space with excess material of unwanted sizes. Crushed rock can be produced in different sizes by changing crusher settings and screen sizes. Fine sizes of crushed rock may be augmented by crushing material normally of gravel size. The size distribution of the raw material is the main factor controlling the amount and size distribution of different products, especially in the sand and gravel categories. For instance, because of the fine size of the raw material in the Whittier and Palos Verdes Hills, plants using this raw material produce 80 or 90 percent in the size range of sand, with a minimum of crushed rock.

Soapstone

Talcose rock known commercially as "soapstone" occurs in the Sierra Pelona and on Santa Catalina Island. One deposit near Boiling Point is now active, but a number of inactive deposits are reported in the upper Bouquet Canyon area (see tabulated index). Serpentine facing stone produced on Santa Catalina Island was in part talcose (see in dimension stone section and in tabulated index).

Katz Soapstone Deposit. Location: sec. 8, T. 5 N., R. 13 W., S.B.M., on the south flank of the Sierra Pelona, about 5½ airline miles northwest of Acton and half a mile north of Highway 6 at Boiling Point. Ownership: Dr. Leon Katz, 9837 Foothill Boulevard, San Fernando, California, owns 160 acres.

The Katz soapstone deposit has been continuously active since it was first opened in 1935 and has yielded as much as 6,000 tons yearly. The product is marketed to consumers in several industries for use as a filler.

The soapstone is quarried from bodies of talcose and chloritic rock along a fault zone in pre-Cambrian (?) Pelona schist. The zone has been explored and mined in four open pits disposed in a line about half a mile long striking N. 70° W. Exposures of commercial rock in these pits are as much as 50 feet wide. The Pelona schist is moderately contorted adjacent to the mineralized belt; the schistosity generally strikes northwest to west and dips within 20 degrees of vertical. The schist consists essentially of albite, muscovite, and chlorite, with serpentine minerals and tremolitic amphibole (rarely asbestiform) among minor constituents. Quartz veins as much as 8 feet wide are common in the sheared zone. The altered material, although consistently about as soft as talc, shows a wide range in mineral content and is colored from gray to brown. The principal observed constituents are serpentine, chlorite, and talc.

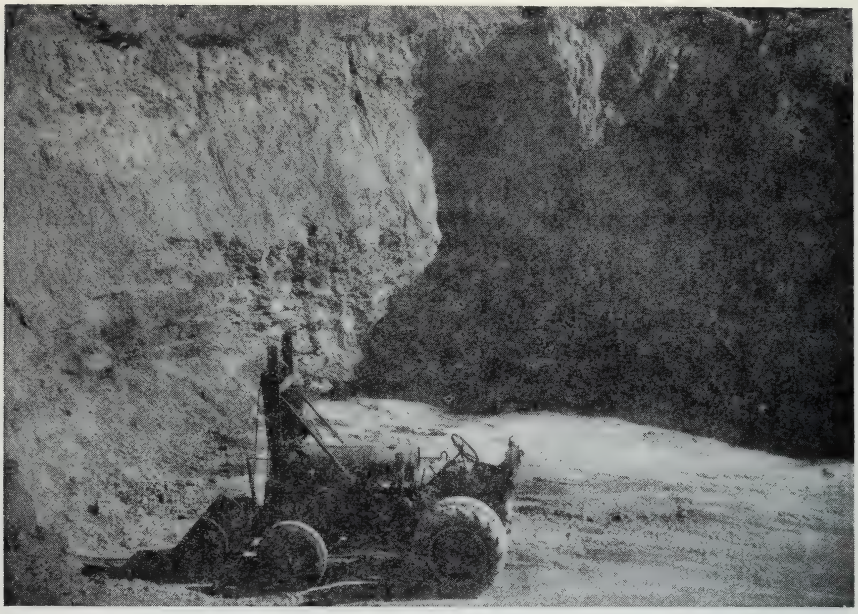

FIGURE 14. Working face of Katz soapstone quarry near Boiling Point. View north toward fractured talcose rock of Pelona metamorphic series.

Most of the mining has been done in the end pits of the row of four. The westernmost pit has an open face about 100 feet in slope length and about 100 feet wide at the base. Blasting is required in mining this pit. The largest and currently active pit is the easternmost, where the soapstone is largely a fine-grained, flaky, chloritic schist and so abundantly fractured as to make blasting unnecessary. This pit is cut in two benches each about 20 feet high, and covers a horizontal area about 100 by 75 feet, nearly half on each bench level. A bulldozer is hired about once a year to make a stockpile of 5,000 or 6,000 tons of the rock, which is then loaded to truck by skip-loader as desired. Soapstone still exposed in the inactive pits constitutes a minable reserve. Material of several types from the different pits is blended to meet requirements of consumers. The mined material is trucked in the crude state to grinding mills in the Los Angeles area. One man conducts the operation.

Specialty Sands

Foundry Sand. Foundry sand, including both molding sand and core sand, has been obtained from a number of localities in Los Angeles County for many years (Wright, 1948, pp. 50-54). Both clay-free and naturally bonded sands are produced. The main requirements of the base sands are adequate refractoriness, proper grain size, and sufficient durability (Ries, 1948). Sand mixtures are prepared in consideration of the metal to be poured, casting size and shape, metal-section thickness, and pouring temperature. By blending natural sands of different properties, sands meeting different specifications are produced. Sieve analysis, proportion of bonding clay, and mineral content of different sands are closely controlled. Chemical analyses are also carefully considered; satisfactory sands consist mostly of silica, with minor proportions of alumina, iron oxide, magnesia, and lime.

Silica sand of high purity is used for high-temperature castings of steel. Calcium carbonate is undesirable because heat of the molten metal releases carbon dioxide gas which creates bubbles in castings. A large tonnage of foundry sands, of types which do not occur here, are brought into the county from other California counties, Nevada, and Illinois. Depletion of established deposits and encroachment of residential building developments are steadily decreasing the known reserves of foundry sand, although suitable materials are probably abundant in undeveloped sites.

In Los Angeles County foundry sand has been produced from deposits in El Segundo, near Montrose, near Elysian Park, and in the Torrance-Redondo area. Feldspathic sand produced from dunes west of El Segundo is suitable for iron and non-ferrous metal casting and is used both for synthetic sands and in cores. Massive fractured silica rock from the Quartz Hill deposit near Montrose, inactive since 1949, has a silica content sufficiently high to meet steel-casting requirements (Wright, 1948, pp. 43-44). Microscopic fractures in this rock enable it to be crushed to foundry specifications, to pass 10-mesh and be retained on 40-mesh screens. Bonding clay must be added to both the El Segundo and Quartz Hill material. Naturally bonded sand known as ''Los Angeles Heavy'' has been produced from alluvial ravine fill near Elysian Park for many years, and is mostly used for heavy iron castings and soil pipe. Stratified valley-floor alluvium in the Torrance-Redondo area yields naturally bonded sands used principally in heavy iron casting. Sands from different localities in this area contain various percentages of clay.

All foundry sand deposits in Los Angeles County are mined by open-pit methods. Blasting is rarely required because the sand is virtually unconsolidated. Skip loaders, power shovels, or spiral loaders fill trucks at the pits for the haul to plants or to consumers. At the plants the material is treated in roll crushers and screens to disintegrate lumps without reducing grain size. Sands of different characteristics are mixed together (mulled) to produce sands specified for particular uses. Sand from the Elysian Park and El Segundo areas is trucked directly to foundries without crushing or screening.

Locomotive Sand. Locomotive sand, which is used to give locomotive driving wheels traction on slippery tracks, is produced at a rate exceeding 40,000 tons each year in Los Angeles County. Consumption of locomotive sand increases in winter when tracks are wet or icy, but sand is used throughout the year by most loaded trains ascending and descending grades.

One operator in Los Angeles County meets most of the sand requirements of all major railroads operating in the southern California area. The sand is mined from dune deposits in the Standard Oil Refinery in El Segundo. A bulldozer moves the sand to a bucket elevator which fills a hopper. Trucks haul from the hopper to a nearby rail siding where a high loader fills 50-ton gondolas. The sand is shipped by rail to main railroad yards where it is placed in the engines. No screening or drying of the sand is necessary.

Locomotive sand specifications include both chemical and physical properties. Silica and aluminum oxide should constitute the bulk of the material, whereas iron oxide, clay, vegetal matter, and silt are unde-

sirable. Not over 10 percent should be held on 20-mesh nor more than 10 percent pass 80-mesh screens. It must not cake and it must not fuse below 2700° F.

Small amounts of sand from this deposit are sold to foundries for use as core sand, and to several companies for use as marble-cutting sand. In the latter use the uniform fineness and consistent hardness of the sand particles are desirable.

Sandblasting Sand. About 50,000 tons of sand used for sandblasting are produced each year in the county, mainly from dune sand deposits near El Segundo. Two sand and gravel plants produce sandblasting sand by special treatment of part of their sand output. During the past 15 years sand has come into wide demand for this purpose. Sandblasting equipment is used principally in the cleaning of building exteriors and in the preparation of large metal structures for painting.

Clean dune sands are used with little processing other than drying. Composition and grain size specifications generally are not rigid, although finer sand is more desirable for finer finishing, as in automobiles and airplanes. Coarser sand is better suited to heavy steel structures and house exteriors. The coarse sand, used in large quantities in shipyards, is generally brought into the Los Angeles area from Monterey County.

FIGURE 15. Mining sand dunes for sandblasting sand. Paramount Sand Company operation north of El Segundo; view west toward back of beach dunes.

In the El Segundo area, sandblasting sand is produced from the extensive dune deposits which extend for miles along the ocean front and are as deep as 100 feet. The particles are sub-rounded to subangular and generally fine and even grained. Quartz particles are most abundant but large percentages of feldspar and small percentages of garnet, zircon, and dark, heavy minerals are present. A negligible proportion of clay or fine material is present and organic material is generally limited to the surface. Blasting sand is also produced from

alluvial sand at one sand, gravel, and crushed rock plant at Irwindale, and another in the Palos Verdes Hills.

In the El Segundo area all sand is mined on the landward side of a row of inactive beach dunes. All pits are in a belt less than a mile long. The dunes are mined throughout a vertical range of 50 to 100 feet, down to a soil layer on which the dune rests. Skip loaders place the loose material on trucks for the haul to plants or storage yards. Screening removes organic and other foreign material, but in only one operation is the sand separated into size grades. This operator produces a small amount of coarse sand, greater than one-eighth inch screen size. Several operators dry the sand in rotating kilns but much of the sand is sun dried.

At Consolidated Rock Products Company's Irwindale plant No. 7, some of the aggregate sand is dried and further screened to sizes appropriate for use in sandblasting. This is also done at the Richard R. Ball plant near Walteria. At each of these plants sandblasting sand constitutes a minor percentage of the total production.

A small amount of the dune sand produced in El Segundo is used for purposes other than sandblasting. Some is used for foundry sand, a small amount in sweeping compound, and considerable tonnages for sandboxes in playgrounds.

Salt

Although occurrences of rock salt (halite) have not been reported to exist in Los Angeles County, salt has been produced by evaporation

FIGURE 16. View southeast toward working face of Consolidated Rock Products Company Irwindale pit. Dragline scarifier on original ground level, top center, maintains bank slope and provides loose rock for shovel to load hopper at end of belt conveyor.

of sea water. Salt ponds in the Long Beach area were active before World War I and continued until 1946 when the entire area was in use as an oil field. The only other salt operation was a small venture utilizing brines from Salinas Lake (Bailey, G. E., 1902; Irelan, 1890, pp. 281-282) in Redondo Beach and inactive for the last 40 years.

The Long Beach Salt Company, a subsidiary of Western Salt Company, which maintains offices at 2476 Hunter Street, Los Angeles 21, operated salt ponds and a salt works in the marshes opposite Terminal Island between Wilmington and Long Beach. This company bought the property from San Pedro Salt Company which operated there prior to World War I. About 10,000 tons of salt were produced annually with a gradual decline in tonnage during the last years of operation to about 4,000 tons in 1945, as each year more salt-pond area was diverted to oil drilling. In 1946 the salt operation ceased, leaving the area entirely to the oil industry. The area covered by the salt ponds was reported to be 1,200 acres (Merrill, 1919, p. 511) in 1919 and 250 acres (Sampson, 1937, p. 207) in 1937.

The evaporating, harvesting, and refining procedures employed at the plant have been described (Merrill, 1916, pp. 713-716; Sampson, 1937, p. 207; Tucker, 1927b, pp. 329-330) elsewhere in detail. During the last several years of the operation 12 to 15 men were employed steadily and 20 to 25 more were added during the harvesting season.

Both crude and refined salts were sold, mostly for use in the fish-packing industry and in water-softening processes. A small amount was sold for table use.

Silica

A small tonnage of silica has been produced in Los Angeles County, chiefly for use in glass but only one deposit is now active. Quartz occurs in veins in metamorphic rocks in the Sierra Pelona schist series and the San Gabriel metamorphic complex. Many of the quartz veins common in the Pelona schist series exceed 20 feet in width. Difficulty of access is a deterrent to development of these deposits (Simpson, 1934, p. 414). Most of the production occurred prior to 1925 from veins in the Sierra Pelona, Mint Canyon area, and Antelope Valley.

Silica also has been produced in large tonnages in Los Angeles County in the form of sands. See descriptions of foundry sand, sandblasting sand, and locomotive sand operations in the rock products section of this report.

Davis and Son Mine. Location: sec. 27, T. 2 N., R. 9 W., S.B.M., in East Fork of San Gabriel Canyon about 7 airline miles north of Glendora. Owner: W. V. Davis, Box 214, Azusa, owns one patented claim.

The Davis mine has yielded minor tonnages of silica since it was opened in 1951. The deposit consists of a body of white quartz in deeply weathered dioritic rocks of the complex igneous and metamorphic series widely exposed in the San Gabriel Mountains. The body strikes southward and dips moderately eastward. It is exposed only in a vertical face measuring about 40 by 80 feet, and there is no indication of its volume.

Content of 99.58 percent silica with less than 0.001 percent of iron is reported by the owner. Small tonnages of the material have been sold for use in ceramics, filters, insulation, and various fillers.

Mining is entirely by quarrying. The brittle quartz is drilled and blasted from the vertical face of the outcrop. Equipment includes a 30-ton gravity-fed bin about 100 feet below the quarry face, on 8- by 12-inch Union jaw crusher, an 18- by 10-inch Allis Chalmers roll crusher, bucket elevator, and four-deck vibrating screen. Fragments produced are sized differently according to use.

Perched alluvial material on the property is being sluiced for its gold content. This subsidiary operation is conducted on weekends by one man with the aid of a skip-loader.

Mineral Processing Plants

Nonmetallic Mineral Processing Plants. The following plants accept nonmetallic minerals for milling or processing as noted.

Firm	*Type of service*
American Minerals Co. 840 South Mission Road Los Angeles	Occasionally accepts lots of nonmetallic minerals.
Hidecker Company 800 South Mission Road Los Angeles	Nonmetallic minerals, including perlite and silica.
Hill Bros. Chemical Co. 2159 Bay Street Los Angeles	Small lots of soft, nonmetallic minerals.
Kennedy Minerals Company 2550 East Olympic Blvd. Los Angeles	Nonmetallic minerals.
Ontario Rock Milling Co. 7750 East Madison Paramount	Nonmetallic minerals, particularly roofing-granule materials.
Dr. W. J. Ross Products Co. 1538 West 259th Street Harbor City	Lignite and nonmetallic minerals.
Southern California Minerals Co. 320 South Mission Road Los Angeles	Nonmetallic minerals.
Sunshine Mica Co., John K. Bice et al. 12234 Los Nietos Road South Whittier	Mica (currently from out-of-state sources) ground using both wet and dry processes.

Tungsten Processing Plants.

Firm	*Type of service*
Gage Ore Testing Plant Hi-Grade Mine Acton	Small lots of tungsten and gold ores tested to determine best milling process.
Pacific Metallurgical Products Company 720 North Georgia Avenue Azusa	Tungsten powder produced from tungsten-bearing concentrates.
Sun Valley Tungsten Co. 11370 Pendleton Street Sun Valley	Tungsten ores milled.
Tungsten Processing Co. 8855 Dice Road Los Nietos	Tungsten ores milled.
Western Metallurgical Co. 9553 East Rush Street El Monte	Tungsten oxide produced from tungsten-bearing concentrates.

Oil and Gas

Accumulation of Petroleum. Although the origin of petroleum has long been a subject for controversy, the consensus is that most petroleum results from the decomposition of organic material laid down in shallow marine basins. As fine-grained sediments contain more organic matter than coarser-grained sediments, it is likely that highly organic marine shales are the source rocks for most of the world's petroleum. The agents and processes by which the complex organic molecules are broken down to simpler hydrocarbon molecules are still largely unknown.

After formation, petroleum must migrate to a permeable and porous reservoir rock and be trapped there before a potential oil field comes into existence. A trap is any combination of geologic features that prevents upward and lateral migration of petroleum and allows it to collect in pools. A trap may be the result of stratigraphic conditions, structural deformation, or a combination of the two.

FIGURE 17. High-octane plant of Richfield refinery. *Photo courtesy Los Angeles Chamber of Commerce.*

Petroleum is associated with gas, generally under considerable pressure. In most of the fields in Los Angeles County the oil pools are surrounded by salt water. The petroleum gas produced in conjunction with petroleum contains varying amounts of liquid hydrocarbon compounds, which, after removal, are grouped as natural gasoline, condensate, and liquefied petroleum gases. The average liquid yield from California oil-well gas is a little more than one barrel per thousand cubic feet of gas.

Location of Oil and Gas Fields. In general, areas with great thicknesses of unmetamorphosed marine sediments are possible oil areas, particularly if the sediments vary somewhat in thickness and lithology. Two areas in Los Angeles County, the Los Angeles basin and the eastern part of the Ventura basin, are favorable to oil accumulation. During much of Tertiary time these areas were below sea level, receiving large thicknesses of sediment in a marine basin. Structures in which oil has accumulated were created by the deformation of the rocks in these basins during late Tertiary and Quaternary time. The larger part of the Los Angeles basin remains essentially a topographic basin, but the area of the Tertiary eastern Ventura basin is now a mountainous region. The following discussion of the oil fields in the county covers first those fields in the Los Angeles basin, and later those in the eastern Ventura basin.

Los Angeles Basin

The Los Angeles basin covers about 1,000 square miles, mostly nearly flat land but with a few low hills rising above the plain. The basin has passed through a complex sequence of geologic events and has been folded and faulted (see section on geology, above) so that a number of traps for the accumulation of petroleum are present. The traps that have been discovered in the Los Angeles basin have yielded almost $3\frac{1}{2}$ billion barrels of oil and more than $3\frac{1}{2}$ million cubic feet of gas from a proven area of approximately 30,000 acres*. In many of the highly productive fields a series of successive reservoir sands is interrupted only by intervening shales. The enormous thickness of producing zones thus obtained gives the effect of a number of fields, one on top of the other, with a recovery of over 100,000 barrels of oil per acre for the average of the proved fields.

Petroleum is associated with two structural trends across the central part of the basin and with various structures around the margin of the basin. The principal central structure is the Beverly-Newport uplift; the other is the Playa del Rey-Wilmington trend. These parallel the Santa Monica-Redondo coast, and north of Wilmington are separated from one another by El Segundo plain, a synclinal area from 3 to 4 miles in width. The Coyote Hills uplift, involving several oil fields in Orange and Los Angeles Counties, trends northwest, and is separated from the Beverly-Newport uplift by a broad synclinal area, some 10 to 14 miles in width, known as the Downey plain. A third synclinal area 3 to 4 miles wide lies between the Coyote Hills uplift and the eastern marginal fields of Montebello, Whittier, Sansinena, and Puente Hills.

The Beverly-Newport uplift coincides with the Newport-Inglewood belt of faulting and trends northwest from the San Joaquin Hills to the Santa Monica Mountains as a readily visible topographic feature. Oil occurs along this trend in a series of anticlines in several of which faulting near the crests and cross-faulting have had marked influence on the accumulation and distribution of the oil.

The Playa del Rey-Wilmington trend is close to the southwest margin of the basin. Most of the structures along this trend consist of broad

* Except where otherwise noted statistics on petroleum are taken from the Annual Review of California Oil Production published by the Conservation Committee of California Oil Producers, 1952.

*Geologic formations in the oil fields of the Los Angeles basin and margins.**

AGE		FORMATION		LITHOLOGY
RECENT		Alluvium		Gravel, sand, silt; valley fill, alluvial fans, flood plain and marsh deposits, sand dunes.
		Terraces		Marine and nonmarine terrace gravel and sand.
PLEISTOCENE	Upper	Palos Verdes La Habra		Marine (Palos Verdes) and nonmarine (La Habra) terrace deposits; clay, silt, sand, gravel, conglomerate.
	Lower	San Pedro sand Timms Point silt Lomita marl		Principally marine sand, gravel, clay, silt, marl.
PLIOCENE	Upper & middle	Pico		Marine sandstone, siltstone, shale, conglomerate.
	Lower	Repetto		Marine sandstone, sandy siltstone, claystone.
MIOCENE	Upper	Monterey (Puente, Modelo)	Malaga mudstone	Marine sandy micaceous siltstone, platy and diatomaceous shale, sandstone, conglomerate.
			Valmonte diatomite Altamira shale	Marine diatomite; diatomaceous, calcareous and dolomitic shale; mudstone, sandstone, volcanic ash, phosphatic layers and nodules, schist conglomerate.
	Middle		Topanga	Marine shale, siltstone, sandstone, some conglomerate.
	Lower	Vaqueros		Marine basal conglomerate, sandstone, shale, basic intrusives.
OLIGOCENE		Sespe		Principally nonmarine sandstone, claystone, conglomerate lenses, intrusive volcanic rocks.
PRE-TERTIARY		Catalina schist		Metamorphosed sandstone, gneiss, quartzite, including serpentine, talc, glaucophane schist.

* Idealized chart listing most of the geologic formations found in the oil fields of the Los Angeles basin and its margins, with their ages, and lithology. Data generalized after various sources including A.A.P.G., 1952; Eckis, 1934; Oakeshott, 1954a; Schoellhamer, 1951; Wissler, 1943; Woodford, 1954; Woodring, in Gale, 1933; and Woodring, 1946.

anticlines extending in a northwesterly direction approximately parallel to the Beverly-Newport trend.

Several of the oil fields along the eastern margin of the Los Angeles basin are closely associated with the Whittier fault zone. The fields along the northern margin of the Los Angeles basin follow a complex zone of folding and faulting to merge with the Whittier fault zone on the east.

The Coyote Hills uplift lies parallel to the Whittier fault zone but is farther west. It is a minor structural trend on which are several prolific fields, all anticlinal.

In 1952 a total of 123,443,000 barrels of oil was produced from oil fields in the Los Angeles basin, including about 49,000,000 barrels of oil produced from fields in Orange County. As of January 1, 1953, the proved crude oil reserves of the Los Angeles basin (including Orange County) were estimated at 1,219,000,000 barrels. Total Los Angeles basin gas production in 1952 was 118,701 million cubic feet, of which about 87,100 million cubic feet came from Los Angeles County. Gas reserves in the Los Angeles basin were estimated in July 1951 by the California Division of Oil and Gas (1951) at 1,369,378 million cubic feet, of which about 840,730 are in Los Angeles County.

Oils of the Los Angeles basin range in gravity from 8° to 40° Baumé. In nearly all the fields the oils become progressively lighter with depth.

Most of the exploratory efforts in the Los Angeles basin have been confined to known trends. Large areas have not been adequately tested. The future prospects for oil discovery in the Los Angeles basin are not limited by the presence or absence of favorable geologic conditions so much as they are by the surface culture and sustained building activities which make difficult the leasing of a block for an exploratory test (Edwards, 1951).

Municipal ordinances have been adopted by most of the cities in Los Angeles County that contain oil wells near populated areas. These ordinances provide for a maximum safety program to prevent accidents and to permit expansion of oil districts in an orderly manner.

*Twelve largest gas-producing oil fields in Los Angeles County in 1951.**

Field	Net withdrawal of gas (millions of cubic feet)	
	1951	Cumulative to 1-1-53
Wilmington	53,631	501,954
Del Valle	9,696	54,796
Long Beach	9,571	957,068
Dominguez	6,742	311,937
Rosecrans	5,245	150,091
Santa Fe Springs	5,054	737,572
Seal Beach	4,737	120,152
Inglewood	3,768	132,535
Montebello	2,589	172,288
Newhall-Potrero	2,229	21,988
Torrance	1,463	93,895
Playa del Rey	560	33,331

* Conservation Committee of California Oil Producers Annual Review 1951, table X, ff. p. 65, 1952.

*Yield of major oil fields in Los Angeles County.**

Los Angeles basin

Field	Number of producing wells 1-1-52	Production in thousands of barrels	
		Year 1951	Cumulative to 1-1-52
Wilmington	2,372	50,806	557,693
Long Beach	1,178	8,499	758,341
Santa Fe Springs	526	5,132	538,632
Inglewood	409	4,951	179,790
Dominguez	346	4,286	192,215
Seal Beach	222	4,118	126,627
Torrance	758	2,522	133,285
Montebello	334	2,014	157,526
Rosecrans	211	1,640	68,488
Sansinena	32	1,038	1,786
Playa del Rey	108	625	55,655
East Los Angeles	18	466	2,472
Potrero	37	302	7,982
Whittier	125	279	21,755
Lawndale	11	163	2,029
El Segundo	20	124	12,527
Alondra	5	98	1,100
Total	6,712	87,063	2,817,903
Ventura basin			
Placerita	350	3,982	14,921
Newhall-Potrero	84	2,865	25,746
Aliso Canyon	72	1,986	13,696
Del Valle	74	1,677	14,737
Ramona	119	1,505	9,376
Oak Canyon	20	554	5,406
Honor Rancho	6	294	330
Castaic Junction	7	268	305
Total	732	13,131	84,517
State total	29,613	354,561	8,998,505

* Conservation Committee of California Oil Producers Annual Review 1951, Statistical section, pp. H-O, 1952.

In addition to restrictions imposed upon spacing of wells and establishment of oil districts, the city of Los Angeles may impose the following conditions * and many others not listed:

(1) "All drilling and production operations shall be conducted in such a manner as to eliminate as far as practicable, dust, noise, vibrations and noxious odors;

(2) "Adequate fire fighting apparatus and supplies, approved by the Fire Department, shall be maintained on the drilling site at all times during drilling and production operations;

(3) "All parts of the derrick above the derrick floor not reasonably necessary for ingress and egress, shall be enclosed with fire resistive, sound-proofing material approved by the Fire Department, and the same shall be painted or stained so as to render the appearance of said derrick as unobtrusive as practicable."

In the following section, oil fields are described in alphabetical order under the headings Beverly-Newport group, Playa del Rey-Wilmington

* Los Angeles municipal ordinance no. 97950.

fields, eastern and northern marginal fields, and fields along the Coyote Hills uplift, respectively.

Beverly-Newport Group

The Beverly-Newport uplift is marked by a discontinuous line of low hills and scarps which, in general, are the surface expressions of anticlines and faults respectively. Nine producing oil fields occur at fairly regular intervals along the uplift. Two of these oil fields, the Huntington Beach and Newport fields, are in Orange County and are not covered in this report. The fields are described below as they occur from northwest to southeast.

Beverly Hills Oil Field (Hoots, 1931, pp. 132-133; Soper, 1943, p. 287). The Beverly Hills field is the northernmost of the Beverly-Newport group. It is in the city of Los Angeles just south of the intersection of Santa Monica and Wilshire Boulevards. Residential construction has almost obliterated this field and only two wells remain on production. The field was discovered in 1908.

Although the Beverly Hills field is covered by Recent and Peistocene alluvial deposits, a section in the southeastern part of the field shows marine Pleistocene strata to a depth of several hundred feet underlain successively by upper Pliocene strata to about 2,400 feet, lower Pliocene strata to 3,070 feet, strata representing the Pliocene-Miocene transition zone to 3,340 feet, and Miocene strata to the deepest penetration of a well at 4,970 feet. The strata consist of clay shale, sandstone, and conglomerate.

Most of the oil was produced from sandstone in the Pliocene-Miocene transition zone over an area of about 40 acres. Some oil was obtained above this zone from sandstone in the Repetto formation. The total thickness of the producing zones ranged from about 300 to 600 feet.

The structure of the Beverly Hills field consists of a pronounced asymmetrical dome of triangular shape elongated in an east-west direction. The structural closure of the fold is probably about 500 feet. Dips on the north flank are about 15° and dips on the south flank are much steeper.

Total production of oil from the Beverly Hills field to May 1, 1953 was 4,165,000 barrels. In 1952 an average of 2,416 barrels per month was produced from the two operating wells. Only a negligible amount of gas has been recovered from this field.

Inglewood Oil Field (Driver, 1943; Woodward, 1941). The Inglewood field lies within the Baldwin Hills, about 4 miles southeast of the Beverly Hills field. Discovery was made in September 1924 by drilling on a structure outlined by geologic mapping.

Recent alluvium and stream-terrace deposits cover the crest and southern slopes of the Baldwin Hills. Pleistocene sediments, from 80 to 200 feet thick, consisting of clay, sand, sandstone, gravel, and conglomerate, underlie the alluvium and stream-terrace deposits and also crop out in the area. Below the Pleistocene sediments are about 1,700 feet of the Pliocene Pico formation, consisting of sandstone, shale, and siltstone; 3,150 feet of Pliocene sediments of the Repetto formation, composed chiefly of shale interbedded with sandstone; and Miocene sediments of the Modelo formation, consisting of shale, silty sand, and

phosphatic shale. In the deepest well drilled a volcanic-sedimentary series was encountered between 8,358 and 8,420 feet. This series is believed to be of middle Miocene age. Middle Miocene silty sandstone and shale of the Topanga formation were found from 8,420 to 8,760 feet.

Five producing zones total several thousand feet in thickness. The three main productive oil zones, the Vickers, Rindge, and Rubel, occur in Pliocene sandstone. The Moynier zone is in the Modelo formation and the Sentous zone is in the middle Miocene Topanga formation. The Sentous zone is stratigraphically the deepest oil zone developed within the Los Angeles basin, except for oil that has migrated into pre-Cretaceous schist.

The field is mainly within a northwest-trending anticline whose crest has dropped between two faults to form a graben, which in turn is offset by several cross-faults. The easterly of the two principal faults is known as the Inglewood fault.

The Inglewood oil field has yielded 186,428,000 barrels of oil and 137,498 million cubic feet of gas up May 1, 1953. Almost 5 million barrels of oil and 3,763 million cubic feet of gas were produced from this field in 1952 from 430 active wells covering an area of about 950 acres.

Potrero Oil Field (Willis and Ballantyne, 1943). Third from the north in the line of fields extending from Beverly Hills to Newport Beach is the Potrero oil field. It is a structural dome reflected in the topography as a broad uplift with a definite oval outline. Discovered in 1927, the field covers about 285 acres and is noteworthy for the high gravity of its oil, which averages 42.0° Baumé.

The formations encountered in the Potrero field are: (1) several hundred feet of Pleistocene sand, gravel, and clay; (2) about 2,650 feet of Pico (upper Pliocene) soft greenish clay-shale, conglomerate, and sandstone with thin streaks of shale; (3) about 4,100 feet of Repetto (lower Pliocene) sandstone interbedded with shale, shaly sandstone, and shale; and (4) several thousand feet of upper Puente (upper Miocene) sandstone and shale.

At least eight oil zones have been found in the field, six in the Repetto formation and one each in the Pico and upper Puente formations. The deepest zone is at a depth of 8,250 feet in one well and the shallowest zone is at a depth of about 2,900 feet in several wells. The most prolific zone in the field is the "Cypress 3" zone, averaging 200 feet in thickness at a depth of about 4,000 feet.

The Potrero oil field is on a dome divided into four blocks by three faults. Accumulations of oil occur in the crest of the dome and against the faults.

The field has yielded 8,411,000 barrels of oil and 26,234 million cubic feet of gas to May 1, 1953. In April, 1953, the field yielded 24,104 barrels of oil and 135 million cubic feet of gas from 37 wells.

Rosecrans Oil Field (California Railroad Commission, 1942). The Rosecrans field is about 10 miles south of the center of the city of Los Angeles, southwest of the Potrero oil field. Oil and gas showings in shallow water wells were noted in this area long before the discovery of the field in 1924.

The field is overlain by late Pleistocene deposits, consisting of a few hundred feet of sand and gravel, below which are Pliocene sediments composed of fine- to coarse-grained gray sand interbedded with hard massive shale, sandy shale, and siltstone. These include the Pico formation, about 3,450 feet thick, and the Repetto formation, about 3,200 feet thick. The Pliocene-Miocene contact is conformable. At least 3,500 feet of upper Miocene sediments of the Puente formation also have been penetrated. These are fine- to medium-grained sands interbedded with laminated platy shale, dark brown massive shale and siltstone.

Several oil and gas zones occur at depths ranging from 4,150 feet to 8,600 feet. The Padelford, Maxwell, Hoge, and Zins zones, ranging from 270 to 750 feet in thickness, are in Pliocene rocks; and the O'Dea, 7th, and 8th zones, ranging from a few hundred to 500 feet in thickness, are in Miocene rocks.

The Rosecrans field is on an anticlinal fold along the Beverly-Newport uplift. The fold trends northwest and is resolved into three separate domes probably separated by transverse faults. The oil-producing area along the northwest dome is known as the Athens area and the field is frequently designated as the Athens-Rosecrans oil field. The remainder of the field is divided into the Central and Main Street areas. In 1949 the Howard Townsite area north of the Central area was added to the field.

As of May 1, 1953, the Rosecrans field has yielded 70,712,000 barrels of oil and 156,177 million cubic feet of gas from an area of about 1,050 acres. In April 1953 production from 226 wells totaled 126,208 barrels of oil and 333 million cubic feet of gas.

Dominguez Oil Field (Grinsfelder, 1943; Parker, 1952, p. 18). The Dominguez field is a few miles southeast of the Rosecrans oil field and about 4 miles northwest of the city of Long Beach. It is on a prominent rise known as Dominguez Hill. The field was discovered in September 1923.

In the field about 40 feet of Recent alluvium overlie about 630 feet of Pleistocene sediments of the Palos Verdes and San Pedro formations. An unconformity separates Pleistocene rocks from about 5,050 feet of Pliocene sandstone and shale of the Pico and Repetto formations. Several thousand feet of upper Miocene sediments were penetrated by a well drilled to the schist basement at 12,328 feet below sea level.

The field contains nine oil-bearing zones ranging from 3,700 to 8,900 feet in depth. The first five zones, First to Fifth Callender, are in the Repetto formation. The lower Callender zones are in upper Miocene sandstone. The zones range in thickness from 188 to 825 feet. A gas zone 1,100 feet thick occurs in the lower Pico formation above the first oil zone. The oil field is on a northwest-trending faulted anticline. The faults act as pressure barriers.

The field has yielded 197,318,000 barrels of oil and 319,354 million cubic feet of gas over an area of 1,300 acres as of May 1, 1953. In April 1953, production of 302,413 barrels of oil and 421 million cubic feet of gas was obtained from 339 wells.

Long Beach Oil Field (Stolz, 1943; Parker, 1952, p. 17). The Long Beach field is in the northern city limits of Long Beach and in the town

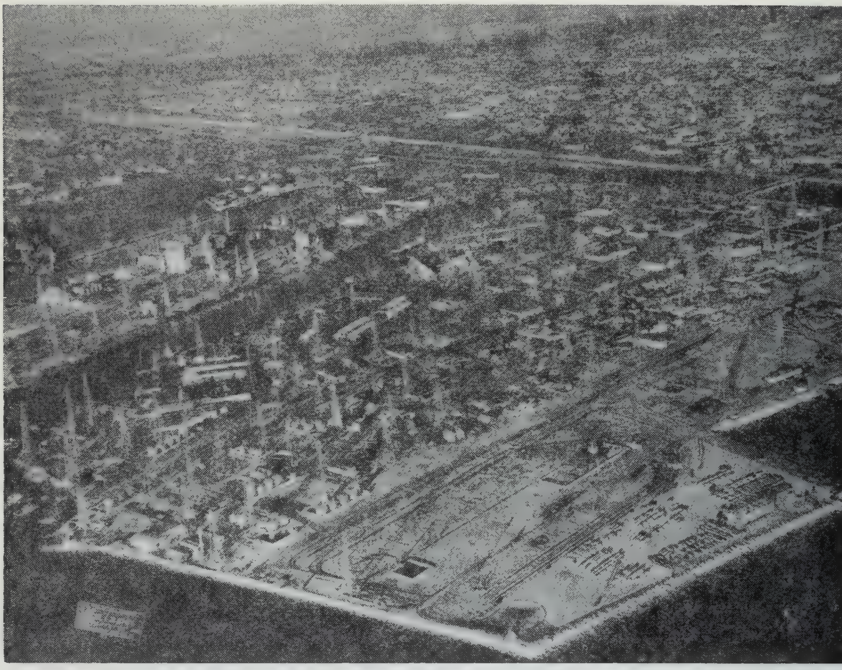

FIGURE 18. Aerial view northeast toward Wilmington oil field (foreground), Los Angeles River (middle ground), and Long Beach oil field (rear). *Watson Air Fotos, Long Beach, photo, courtesy Los Angeles Chamber of Commerce.*

of Signal Hill about 2 miles from the ocean. It was originally called the Signal Hill field after a topographic rise extending 365 feet above sea level, and is often still referred to as such. The field has been a prolific producer since its discovery in June 1921 and ranked tenth among the producing fields in California in 1952.

The formations exposed at the surface are composed of loosely consolidated sand and gravel of Quaternary age. Pleistocene sand, gravel, and clay of the Inglewood and San Pedro formations extend from the surface to a depth between 1,000 and 1,500 feet. The Pliocene series is approximately 3,600 feet thick and consists of alternating beds of sand, sandy shale, and shale, with occasional streaks of hard shell. The Miocene rocks are more indurated and interbedded than the Pliocene sediments and consist of sand, silt, and shale. A well that encountered the schist basement at a depth of 14,950 feet passed through about 9,800 feet of Miocene sediments.

Oil is produced from lower Pliocene (lower Pico and Repetto formations) and Miocene beds in six closely spaced zones extending from 2,400 to 8,000 feet, and a deeper zone lying between 9,600 and 11,000 feet.

The field is on a faulted, narrow, asymmetric anticline which trends northwest. The Cherry Hill fault extends the entire length of the field and the Northeast flank fault extends from the east end of the field northwest for about a mile, where it is cut off by the northeast-trending Pickler fault.

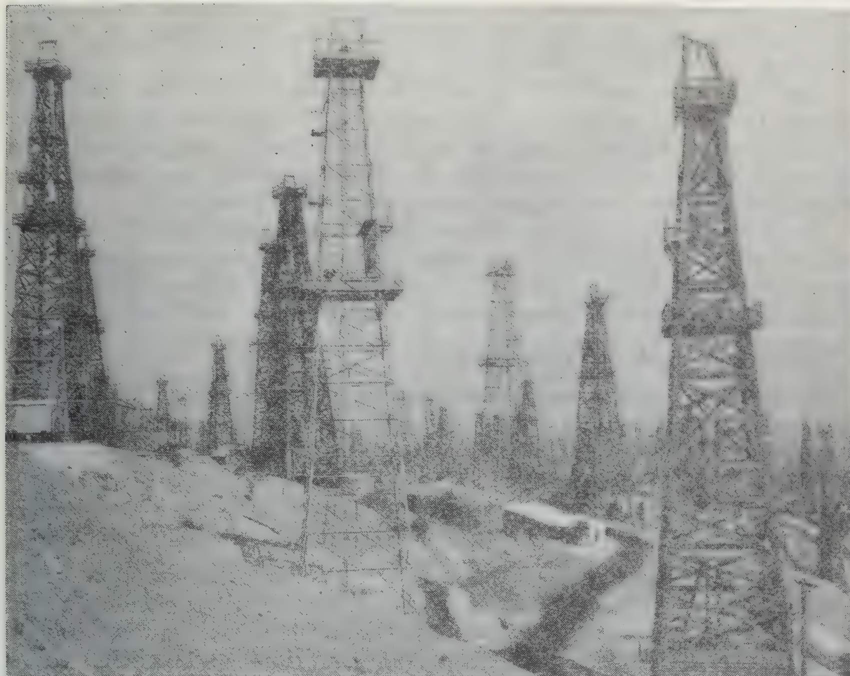

FIGURE 19. On Signal Hill, Long Beach oil field. *Photo courtesy Los Angeles Chamber of Commerce.*

As of May 1, 1953, the Long Beach field has yielded 768,750,000 barrels of oil and 968,327 million cubic feet of gas from an area of only 1,400 acres. In April 1953 the field yielded 612,990 barrels of oil and 573 million cubic feet of gas from 1,159 wells.

Seal Beach Oil Field (Bowes, 1943). The Seal Beach field is about 3 miles east of the center of the city of Long Beach. The eastern end of the field is in Orange County. The Seal Beach field is one of the most prolific producers of the fields along the Beverly-Newport trend. It was discovered in August 1926 after 13 dry holes had been drilled during the preceding 5 years.

The stratigraphy of the Seal Beach field resembles that of other fields along the Beverly-Newport uplift. The higher formations consist of a 1,200-foot thickness of bluish gray silt and clay with streaks of loosely consolidated sand and gravel. These are Pleistocene (Timms Point formation) and upper Pliocene (Pico formation). The remainder of the Pliocene series consists of interbedded sand and bluish gray shale grading downward to brownish gray shale. The Pico and Repetto formations are about 2,900 and 2,500 feet thick respectively. Underlying the Repetto formation is the Puente formation of Miocene age, consisting of medium-grained to silty sand interbedded with brown and black platy to massive shale. The deepest well drilled penetrated approximately 3,200 feet of upper Puente sediments.

At least six zones have yielded oil in the Seal Beach field. Four zones, aggregating over 1,400 feet in thickness, are in the Repetto formation,

and the two lower zones in the Puente formation aggregate about 2,800 feet in thickness. Wells penetrating these zones were drilled to depths ranging from 4,400 to 6,900 feet.

The structure consists of an anticline separated into two elongated domes trending northwest. The northwest dome occupies Alamitos Heights, a hill 80 feet in elevation. A major fault trending northwest is known as the Seal Beach fault. Faulting along the Seal Beach anticline probably was nearly contemporaneous with the folding.

As of May 1, 1953, the Seal Beach field has yielded 131,976,000 barrels of oil and 127,097 million cubic feet of gas from an area of 620 acres. In April 1953 a yield of 327,303 barrels of oil and 455 million cubic feet of gas was obtained from 229 wells.

Playa Del Rey-Wilmington Fields

Oil fields along the northeast-trending anticlines from Wilmington to Playa del Rey include Torrance, Lawndale (and Alondra area), and El Segundo. These fields are sometimes designated the ''schist'' fields because oil has been recovered from pre-Cretaceous Catalina schist or Miocene schist conglomerate in all fields except Torrance. The fields are described below from northwest to southeast.

Playa del Rey Oil Field (Metzner, 1943). The Playa del Rey field extends southeast from Santa Monica Bay across the southern part of the city of Venice into the Del Rey Hills. The field may be divided into Venice, Del Rey Hills, and East areas, discovered in 1929, 1931, and 1951 respectively. From 1942 to 1945 a portion of the Del Rey Hills area was used as a reservoir to store gas produced at the field.

The surface formations are Pleistocene, consisting of about 150 feet of sand and gravel and 200 feet of sandy shale and clay with thin beds of sand. Underlying these are about 2,050 feet of the Pliocene Pico formation, consisting of shale with sandy layers, resting conformably upon about 2,500 feet of sandy shale and shale with thin beds of oil sand of the Pliocene Repetto formation. The Miocene sediments consist of about 500 feet of sandy shale and hard compact black shale, about 300 feet of a dark brown compact nodular shale containing phosphatic nodules, and as much as 234 feet of sand and schist conglomerate. The basement rock is pre-Cretaceous Catalina schist.

Oil is produced from two zones, each in a separate part of the field. The upper zone is about 1,100 feet thick and lies with its top about 900 feet below the top of the Pliocene Repetto formation. This zone is productive in the Venice area only. In the Del Rey Hills and East areas the productive zone is in the sand and schist conglomerate overlying the basement schist. Additional but smaller quantities of oil may occupy discontinuous lenticular streaks in the nodular shale and occur in fractures in weathered parts of the schist.

In the Venice area the basement schist forms a ridge, which is a pre-middle Miocene erosion surface. This schist ridge subsided slowly during middle Miocene time and schist conglomerate and sand were deposited on its flanks when the ridge still remained above sea level. Sediments deposited on the ridge in upper Miocene and Pliocene time were compacted to form a northwest-trending anticline, which formed a trap for the accumulation of oil.

As of May 1, 1953, the Playa del Rey field has yielded 56,421,000 barrels of oil and 56,539 million cubic feet of gas. In April 1953 a yield of 45,787 barrels of oil and 73 million cubic feet of gas was produced from 103 wells covering an area of about 500 acres.

El Segundo Oil Field (Reese, 1943). The El Segundo field is about 4 miles southeast of the Playa del Rey oil field and includes the western part of the town of El Segundo. Magnetometer surveys led to the discovery of the field in August 1935 by outlining a ridge of basement schist. A northern extension of the field was discovered in 1944.

The sedimentary section penetrated in El Segundo field is similar to other fields along the Playa del Rey-Wilmington trend. The top 5,700 feet consists of alternating beds of sand and shale, Pliocene and younger. The underlying upper Miocene section, ranging in thickness from 1,300 to 2,000 feet, is almost entirely shale. A dark brown nodular shale forms the basal part of the upper Miocene series. Miocene sand and schist conglomerate, as much as 100 feet thick, is in contact with an uneven erosion surface of pre-Cretaceous Catalina schist.

Oil is obtained from schist conglomerate and from schist which fracturing and weathering has made locally porous. The porous schist has been encountered only in the western part of the field where it is commonly overlain by impervious shale. Production is obtained from an interval of about a hundred feet at depths ranging from 6,850 to 7,750 feet below sea level.

The Miocene sediments deposited on the Catalina schist ridge or high were compacted to form a dome-like structure. Normal faults cut the Miocene section but seem to have no bearing on oil accumulation.

Total oil production from El Segundo field as of May 1, 1953, is 12,676,000 barrels. In April 1953 the field yielded 8,366 barrels of oil from 19 wells over a proven area of several hundred acres. Negligible amounts of gas have been produced; production in April 1953 amounted to 2 million cubic feet.

Lawndale Oil Field (White, 1950, pp. 11-15; Reese 1943a). The Lawndale field is approximately 1½ miles southeast of the El Segundo field. The topography does not reflect the underlying structure. The upper oil-bearing zone was discovered in 1928; the lower zone was discovered in 1947. Disappointingly, only six wells out of 62 drilled in the upper zone secured commercial production.

Rocks penetrated in the Lawndale field include 800 to 1,000 feet of Pleistocene sand and gravel; about 4,600 feet of Pliocene shale and sandstone; from 2,300 to 2,650 feet of upper Miocene hard, banded shale, streaks of gray or oil-stained sand, nodular shale and a maximum of 100 feet of schist conglomerate and poorly sorted sand; and weathered and eroded basement schist of pre-Cretaceous age.

Production from the upper zone is obtained from the top 300 feet of Miocene (upper Puente) sediments at depths ranging from 5,700 to 6,290 feet. At these depths the sediments have been folded into a small elongated, dome-like structure trending northwestward. Lower-zone production comes from the schist conglomerate and sand overlying high areas of the basement ridge.

The upper zone had yielded a total of 1,159,000 barrels of oil and the lower zone had yielded a total of 1,077,000 barrels of oil to May 1,

1953. Only 5,000 barrels of oil were produced from three wells in the upper zone in 1952 compared to 155,000 barrels of oil produced from eight wells in the lower zone. In April 1953 a yield of 10,502 barrels of oil was obtained, principally from the lower zone. Of 125 proven acres in the field, 20 are in the upper zone and 105 acres are in the lower zone. Cumulative gas production as of May 1, 1953, is 3,613 million cubic feet, with the upper zone yielding only a fraction of one percent of the total. In May 1953 the field yielded 8 million cubic feet of gas.

Alondra Area (White, 1950, pp. 16-18). The Alondra area, covering approximately 50 acres, is about 1½ miles southeast of Lawndale. Oil was discovered in 1946 after several previous attempts had failed.

The stratigraphy is similar to that of the Lawndale field, and oil occurs in sand and schist conglomerate in a structure similar to that of the lower zone at Lawndale. The oil zone is reached at an average depth of 9,100 feet.

The Alondra area has yielded a total of 1,218,000 barrels of oil and 723 million cubic feet of gas as of May 1, 1953. In April 1953 the field yielded 6,444 barrels of oil and 4 million cubic feet of gas from five wells.

Torrance Oil Field (American Association of Petroleum Geologists, 1952; Davis, 1943; Parker, 1952, p. 16). The Torrance field is several miles southeast of the Lawndale field and parallels the northern front of the Palos Verdes Hills about one mile to the north. It merges into the Wilmington oil field at an arbitrarily placed boundary along Wilmington Boulevard. The field was discovered in 1922.

About 600 feet of Quaternary sand, gravel, and clay overlie about 1,900 feet of upper Pliocene soft, silty, blue-gray shale with occasional thin sands. Below are about 1,000 feet of lower Pliocene firm, brownish shale with few sandy layers and local, thin, limey shale shells. Upper Miocene rocks, as much as 2,300 feet thick, consist of hard, brownish shale, in part platy, sandy shale, thin sand beds, and banded and nodular phosphatic shale. The Miocene schist conglomerate is about 50 feet thick and is composed of sandstone and angular to sub-rounded schist cobbles derived from the underlying pre-Cretaceous Catalina schist basement, which, in this area, is composed mostly of gray-green muscovite-chlorite-quartz schist.

The Main oil zone in the Torrance field ranges from 200 to 600 feet in thickness and occurs just below the top of the Miocene section at an average depth of 3,650 feet. The Del Amo zone is almost 200 feet thick and lies at an average depth of 5,200 feet. A third zone, the Tar-Ranger zone, in lower Pliocene sandstone, is productive only in the Harbor City area at an average depth of 3,050 feet.

The Torrance field is on a broad anticline plunging gently southeastward. Stratigraphic conditions have controlled oil accumulation; oil sands of the Main zone are less permeable or tighter to the west and the sands of the Del Amo zone are tighter to the west and north.

As of May 1, 1953, the field has yielded 136,666,000 barrels of oil, of which 118,565,000 have come from the Main zone. This production has come from more than 1,200 wells over an area of about 6,000 acres. In April 1953, the field yielded 217,438 barrels of oil from 767 wells.

Total gas production as of May 1, 1953, is 96,074 million cubic feet; in April 1953 a yield of 145 million cubic feet was obtained.

Wilmington Oil Field (Winterburn, 1952; 1943; Murray-Aaron and Pfeil, 1948). The Wilmington field occupies much of the western part of the city of Wilmington and extends well into the city of Long Beach. In recent years the field has been extended to include an area in San Pedro Bay south of the main Long Beach business district. The Wilmington field yielded some oil as early as 1932 and came into prominence as a major oil field in the fall of 1936. In 1952 the Wilmington field was the largest producing field in California. Production from the area beneath the ocean floor is partly developed by directional wells drilled on shore.

The surface formations are Quaternary sand and gravel ranging in thickness from 500 to 1,000 feet. These sediments lie unconformably upon about 800 feet of upper Pico (Pliocene) alternating sand and siltstone. In some parts of the field the upper Pico member rests unconformably upon the lower Pliocene Repetto formation, but in the northern part of the field the middle Pico member is overlapped by the upper Pico member, leaving an unconformable contact between the middle Pico brown shale, sand, and siltstone and the Repetto formation. The middle Pico member is as much as 200 feet thick. The Repetto formation, consisting of shale, siltstone, and sand, ranges in thickness from 875 feet to 1,150 feet. Below it in depositional contact is the Miocene Puente formation, marked by the predominance of gray-white diatomaceous shale with thin partings of oil sands for the upper 100 feet, grading to platy and brown massive shale. Numerous hard porcelaneous or calcareous shales are found in the Miocene column which is about 4,100 feet thick. Unconformably below the Miocene section is pre-Cretaceous Catalina schist at a depth of about 6,800 feet.

Several productive zones, each several hundred feet thick, are recognized in the Wilmington field. The Tar zone in the Repetto formation ranges in depth from 2,400 to 2,800 feet, with a thickness of 225 to 350 feet. The upper Ranger zone at the base of the Repetto formation is encountered at depths of 2,600 to 3,500 feet, and is from 200 to 340 feet thick. In Miocene rocks are the lower Ranger, Terminal, Union Pacific, Ford, "237", and "schist-conglomerate" zones with respective thicknesses of about 100, 1,100, 475, 950, 350, and 200 feet. The Schist zone in the pre-Cretaceous Catalina schist yields oil from fractures in the otherwise impermeable rock.

The Wilmington field is on a northwest-trending major anticline. The field is divided into six large structural blocks by five main faults which trend northward. Minor faults further complicate these structural blocks.

Several years ago subsidence of the land around Wilmington was noted. The subsidence consists of a downward movement accompanied by a smaller counterclockwise horizontal movement. A fairly uniform rate of downward movement of 0.15 feet a month has been measured at the center of movement. In 1951 the maximum subsidence was about 15 feet; a recent study of the problem indicated that the land will subside to a total depth of 22 feet (Musser, 1952). Probably the chief cause of this subsidence is compaction of the strata owing to the removal of fluids by the numerous oil wells. Subsidence is a serious

problem to the oil operators, many of whom have had to redrill wells because of collapsed casings.

About 620,949,000 million barrels of oil and 555,894 million cubic feet of gas have been produced from the Wilmington field to May 1, 1953. In 1952 the field yielded 48,121,000 barrels of oil from 2,524 wells, almost twice as much as was produced from the next largest field in California. The Wilmington field contains 5,560 proved acres of oil land, the largest proved acreage of any field in Los Angeles County. During April 1953 a yield of 3,749,379 barrels of oil and 3,196 million cubic feet of gas was obtained in the Wilmington oil field.

Northern and Eastern Marginal Fields

The fields along the northern margin of the Los Angeles basin follow a complex zone of folding and faulting which merges with the Whittier fault zone on the east. These marginal fields are described proceeding from west to east and then south.

Salt Lake Oil Field (Soper, 1943a; Hoots, 1931, pp. 130-131). The Salt Lake oil field is in the city of Los Angeles and lies north of Wilshire Boulevard between La Brea Avenue on the east and San Vicente Boulevard on the west. The presence of large seeps of heavy black oil and gas led to its discovery in 1903. Asphalt around the seeps was mined in the early days. These asphalt pits have yielded the remarkable Rancho La Brea fauna of Pleistocene vertebrates. A great part of the Salt Lake field was abandoned when production declined and the land became more valuable for residential and business property.

The stratigraphy and structure of this field are imperfectly known because the wells were drilled by cable tools prior to the time when cores could be obtained.

The surface is covered by Quaternary alluvial deposits of sand, gravel, clay, and sandy clay ranging from 40 to 150 feet in thickness. Below is a series of Pliocene sediments, perhaps 3,000 feet thick, consisting of clayey and sandy shale and sand interbedded with clay and sandy shale. Miocene sediments were penetrated in some of the deeper wells.

Several oil zones were encountered in the Salt Lake field, according to an unpublished report quoted by Hoots (1931, p. 131). An upper zone was reported at depths ranging from 650 to 1,750 feet; a second zone was about 900 feet below the top of the first zone; a third zone, called the Salt Lake zone, was about 2,100 feet below the second zone; and a fourth zone, about 1,000 feet below the top of the Salt Lake zone, was never developed. It is believed that oil accumulated in an anticline probably modified by faulting.

As of May 1, 1953, the Salt Lake field has yielded 43,261,000 barrels of oil. In April 1953 the field yielded 6,145 barrels of oil from seven wells. A total of 110 wells have been abandoned. Gas production from this field has been negligible.

Los Angeles City Oil Field (Soper, 1943b; Vandiver, 1952). The Los Angeles City field is about one mile northwest of downtown Los Angeles. Oil seepages in the field led to its discovery in 1892. After several years of intensive development, restrictions curtailing drilling were issued in 1907 when the city encroached on the field.

Quaternary terrace gravels and alluvium overlie about 1,000 feet of Pliocene beds composed of silty and sandy shale and a few thin layers of pebbly conglomerate. An unconformity separates the upper Pliocene Pico formation from the lower Pliocene Repetto formation and there is a lesser unconformity within the Pico beds. Upper Miocene rocks of the Puente formation lie below the Pliocene sediments, probably with slight disconformity. The Miocene sediments, at least 8,000 feet thick, consist of sandstone, shale, and siliceous and diatomaceous shale.

Two oil zones are in an upper sandstone member of the Puente formation. The first zone, the top of which is about 2,500 feet below the top of the Puente formation, ranges in thickness from 50 feet to 200 feet. The lower oil zone ranges in thickness from 25 to 100 feet and is from 160 to 350 feet below the upper zone. The Puente formation crops out throughout most of the area and all the wells in the field were started and bottomed in this formation. The upper oil zone ranges from a few hundred feet to 1,000 feet in depth below the surface.

During World War II, a well drilled approximately 650 feet north of the intersection of College and Figueroa Streets penetrated a good oil sand 1,710 and 1,770 feet below the old lower zone. About 75 barrels of oil were pumped from this new zone daily.

The Los Angeles City field lies along and south of a narrow zone of minor folding and faulting which occurs as one of several secondary structural features on the south flank of a major anticline known as the Elysian Park anticline.

As of May 1, 1953, the Los Angeles City field has yielded 20,421,000 barrels of oil from a proven area of approximately 1,000 acres. In April 1953 three thousand barrels of oil were produced from 80 wells. Gas production from this field has been negligible.

Montebello Oil Field (Reese, 1943b; Stolz and Woodward, 1943). The Montebello field is on the south flank of the Repetto Hills just north of the town of Montebello. Discovery of the Montebello area of the field in 1917 was followed by discovery of the East Montebello area in 1933 and the West Montebello area in 1938.

Pleistocene silt, sand, and conglomerate of the La Habra formation are exposed at the surface. As much as 500 feet of La Habra nonmarine sediments overlie about 1,500 feet of upper Pliocene (Pico) gray to gray-brown siltstone with fine- to coarse-grained sand lenses. About 5,000 feet of lower Pliocene (Repetto) sediments consist of interbedded gray-brown siltstone, sandy siltstone, fine- to coarse-grained sand, and conglomerate. The lower Pliocene sediments grade into upper Miocene rocks, consisting of interbedded dark gray to brown-gray massive to platy and fine- to medium-grained sand. The deepest well drilled penetrated more than 5,200 feet of upper Miocene strata.

Oil has been produced from eight zones ranging in thickness from 160 to 900 feet. The Montebello area yields oil from only the top three zones but these zones are the thickest in the field, aggregating about 1,900 feet in thickness. The three top zones, the fourth zone, and part of the fifth zone are in lower Pliocene sand and conglomerate; the top of the first zone is at a depth of about 2,200 feet below sea level. The

other zones are in upper Puente sandstone and are productive principally in the West Montebello area. The eighth zone is at a depth ranging from 7,300 to 7,500 feet.

Two anticlines in the area trend approximately west. The West Montebello anticline was formed earlier than the main anticlinal structure of the Montebello field and lies 2 miles southwest of the main anticline. Faulting is minor except for the thrust fault against which oil in the East Montebello area has accumulated.

As of January 1, 1953, the Montebello field has yielded 160,045,000 barrels of oil and 175,602 million cubic feet of gas. In April 1953 a yield of 151,141 barrels of oil and 198 million cubic feet of gas was obtained from 335 wells covering an area of approximately 1,400 acres.

Whittier Oil Field (Holman, 1943). The Whittier oil field is in and around the Puente Hills, east and north of the town of Whittier and in the city limits of Whittier. Several productive oil zones crop out within the limits of the area, and, as a result, several seepages of oil and a number of brea deposits occur in the region. In 1897 a well was drilled near a seepage and was completed as a steady producer at a depth of 984 feet.

Quaternary sand and gravel cover the surface in and around the town of Whittier. Lower Pliocene and upper Miocene strata crop out in the Puente Hills just east of Whittier. The nature of the stratigraphy is known principally from outcrops because practically all the wells were drilled by cable tools and core data are not available for these wells. Several new wells drilled and a geologic report recently published (Kundert, 1952) have clarified the nature of oil accumulation. The lower Pliocene rocks consist of as much as 3,700 feet of interbedded shale, siltstone, sandstone, and conglomerate. Several hundred feet of upper Pliocene rocks are encountered in parts of the field. More than 4,000 feet of upper Miocene sediments similar in nature to the Pliocene rocks were penetrated in the deepest well drilled in the field.

Four oil zones are in lower Pliocene sandstone, one zone is in upper Puente sandstone, and one zone is in middle Puente sandstone. The tops of the first three zones occur about 500 feet apart stratigraphically; the top of the fourth zone is about 1,000 feet below the top of the third zone; the top of the fifth zone is about 500 feet below the top of the fourth zone; and the sixth zone ranges from 2,500 to 4,000 feet in stratigraphic depth below the top of the Puente formation. This latter zone has been faulted against lower Pliocene and upper Puente beds and is found at depths ranging from 1,000 to 3,500 feet. The first and second zones crop out, but are as deep as 1,900 and 2,400 feet respectively in some parts of the field.

Most of the oil has accumulated in a southward-dipping homocline, which is downthrown along the south side of the northwestward-trending Whittier fault zone.

As of January 1, 1953, the Whittier field has yielded 22,105,000 barrels of oil. In April 1953 the field yielded 22,124 barrels of oil from 122 wells covering an area of about 700 acres. Only small amounts of gas have been produced in the past; 4 million cubic feet were recovered in April 1953.

North Whittier Heights Oil Field (Daviess and Woodford, 1949). The North Whittier Heights field is about 2 miles west of the town of Puente and 1 mile northwest of the Turnbull oil field. It was discovered in 1944.

Quaternary terraces and alluvium cover most of the lower areas. The Sycamore Canyon member of the Puente formation and the Repetto formation crop out at higher elevations. As much as 475 feet of Quaternary sediments were encountered in a well which also penetrated 1,165 feet of upper Pliocene sedimentary rocks of the Pico formation and 200 feet of lower Pliocene rocks of the Repetto formation. The presence of two major faults in the oil field has made it difficult to obtain a detailed stratigraphic section. About 1,860 feet of Puente sediments were penetrated in the deepest well which was drilled to a depth of 3,000 feet below the surface.

Oil is produced from zones in the Puente formation. These zones are not well known except for one in the lower part of the upper siltstone member of the Puente formation.

The structure of the field has not been described. The Whittier Heights and Handorf faults merge about 1,000 feet southeast of the field and these faults may have some bearing on oil accumulation.

As of May 1, 1953, the North Whittier Heights field has yielded 37,000 barrels of oil from an area of about 20 acres. During April 1953, three wells yielded a total of 308 barrels of oil.

Turnbull Oil Field (Daviess and Woodford, 1949). The Turnbull field is 2 miles southwest of the town of Puente and 2 miles northeast of the Whittier oil field. It covers about 60 acres and was discovered in October 1941.

Recent alluvium and siltstone and conglomerate of the lower Pliocene Repetto formation cover the surface of the field. The Repetto formation is underlain by the upper Miocene Sycamore Canyon member of the Puente formation, ranging from 1,900 to 2,200 feet in thickness, and consisting of about 1,200 feet of micaceous siltstone and diatomite and thin beds of sandstone and tuff. At least 1,000 feet of siltstone and sandstone of the Puente formation lie beneath the Sycamore Canyon member. Middle Miocene sediments of the Topanga formation were found in one well at a depth of 4,113 feet below the surface (elevation 1,255 feet). Another well (surface elevation 572 feet) penetrated nonfossiliferous, brown, gray, and green fine conglomerate, sandstone, and clay between 5,300 feet and the bottom of the hole at 5,608 feet, in and below the Whittier Heights fault zone. These strata are doubtfully referred to the Sespe formation of Oligocene age.

Oil has been produced from four "Cleavenger" zones, all in sandstone of the Puente formation. The structure is a small flat anticline truncated on the southwest by the Whittier Heights fault. As of January 1, 1953, the Turnbull field has yielded 620,000 barrels of oil and 135 million cubic feet of gas. During April 1953 a total of 1,539 barrels of oil and 2 million cubic feet of gas were produced from four wells.

Sansinena Oil Field (Kundert, 1952; Musser, 1950, pp. 45-46). The Sansinena field is about 1½ miles east of the easterly limits of production

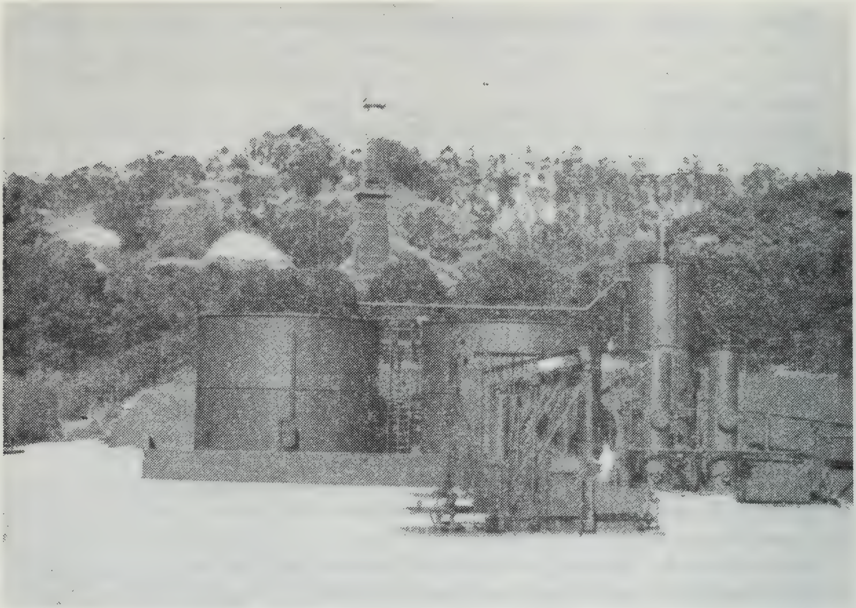

FIGURE 20. Directionally drilled wells in the Sansinena oil field in foreground; drilling rig in background.

of the Whittier oil field. Unlike the Whittier field the Sansinena field is north of the Whittier fault. Discovery of the field was made in 1945.

Recent alluvium and upper Pliocene and upper Miocene sedimentary rocks are exposed at the surface in the Sansinena field. The upper Pliocene Pico formation is exposed south of the Whittier fault and the upper Miocene Puente formation crops out north of the fault.

The producing interval is between 2,600 and 5,450 feet in depth, depending on structural position and the selected interval opened for production. The oil zones are in upper Miocene sandstone of the Puente formation with the exception of one or two which may be in basal Pliocene beds (Musser, 1952, pp. 33-34).

The field is on a plunging anticlinal nose between two faults, of which the Whittier fault is one. The northerly and southerly limits of production have been determined by faulting and the limit of production to the west has been established by edge water. The easterly limit has not been defined.

As of January 1, 1953, the Sansinena field has yielded 4,577,000 barrels of oil and 3,181 million cubic feet of gas from a proven area of over 100 acres. In April 1953 a yield of 225,236 barrels of oil and 140 million cubic feet of gas was obtained from 70 wells. Most of these wells are directionally drilled from islands after oil is discovered in a straight hole. This is in accordance with the Los Angeles County Planning Commission's requirements that sought to protect the rights of the owners of valuable residences and citrus and avocado groves overlying the oil pool.

Puente Hills Oil Field (English, 1926, p. 87). The Puente Hills field is about 2 miles east of the Sansinena field, just north of the boundary

line between Los Angeles and Orange Counties, in the southeastern corner of Los Angeles County. The field was discovered in the early eighties and was the first commercially important field in the state outside of Ventura County.

Upper Miocene rocks of the Puente formation cover the area of the Puente Hills field. In a deep well drilled in 1949 about 875 feet of Puente sediments and 3,585 feet of pre-upper Miocene sedimentary and volcanic rocks were penetrated. Basement rock, encountered about 4,460 feet below the surface, was on epidote-chlorite-quartz-plagioclase schist.

The oil reservoir is probably in the lower Puente formation and may consist partly of crushed shale. Oil is encountered at irregular depths in zones as much as 100 feet thick.

The structure is irregular and is probably a distorted zone in a northward-dipping homocline north of the Whittier fault.

As of May 1, 1953, the Puente Hills field has yielded 3,420,000 barrels of oil and 127 million cubic feet of gas from an area of 500 acres. In April 1953 the field yielded 3,294 barrels of oil and 3 million cubic feet of gas from eight wells.

Oil Fields Along the Coyote Hills Uplift

Parallel to the Whittier trend but farther west are the anticlinal fields of East Los Angeles, Santa Fe Springs, West and East Coyote, Richfield, and Kraemer. The first two and a small portion of the West Coyote field are in Los Angeles County.

East Los Angeles Oil Field (Winterburn, 1952a; Musser, 1946; Johnson, 1952). The East Los Angeles field is about 1½ miles southwest of the West Montebello area of the Montebello oil field. It was actually discovered in 1945, but the discovery well was not placed on production until February 1946.

A well drilled about half a mile east of the field penetrated about 970 feet of Quaternary sand, gravel, and silt, about 2,400 feet of upper Pliocene siltstone and sandstone, about 4,200 feet of lower Pliocene siltstone, sand, and conglomerate, and about 500 feet of upper Miocene sediments. A well drilled about three-quarters of a mile south of the field penetrated a similar stratigraphic section, going through 5,300 feet of upper Miocene sediments before reaching a total depth of 12,930 feet below sea level.

Three oil zones have been found in rocks of the Delmontian stage of the upper Miocene epoch in the interval between 8,000 and 9,000 feet. The upper and lower zones, the Vail 1 and Union Pacific 1 zones, are each about 30 feet thick, and the middle or Union Pacific 3 zone is about 160 feet thick.

The structure is a dome with about 70 feet of closure at the top of the Union Pacific 1 zone. The closure decreases upward until it is negligible in lower Pliocene beds. Faults of small throw are believed to bound the field on the east and west.

As of May 1, 1953, the East Los Angeles field has yielded 2,903,000 barrels of oil and 5,002 million cubic feet of gas. The field covers 160 acres and in April 1953 yielded 23,122 barrels of oil and 29 million cubic feet of gas from 19 wells.

*Geologic formations in the oil fields of the eastern part of the Ventura basin and Soledad basin.**

AGE		FORMATION	LITHOLOGY
RECENT		Alluvium Terraces	Gravel, sand, silt; valley fill, alluvial fans, flood plain deposits.
PLEISTOCENE		Terraces	Marine and nonmarine sand, gravel, conglomerate.
PLIOCENE	Upper	Saugus	
		Pico	Marine sandstone and conglomerate.
	Lower	Repetto	Marine siltstone, shale, sandstone, conglomerate.
MIOCENE	Upper	Mint Canyon	Marine siliceous shale, and sandstone, siltstone, minor conglomerate.
	Middle	Modelo	Interfingering continental conglomerate, sandstone, shale, siltstone.
	Lower	Tick Canyon Topanga	Marine shale, siltstone, sandstone, conglomerate; interbedded volcanic material.
OLIGOCENE		Vasquez	Nonmarine sandstone, conglomerate, shale; abundant interbedded volcanic flows.
EOCENE	Upper		
	Middle	(Las) Llajas	Marine shale, minor sandstone, conglomerate.
	Lower		
PALEOCENE		Martinez	Marine sandstone, shale, conglomerate, with calcareous and concretionary beds.
PRE-TERTIARY		Cretaceous sediments Granitic and schistose basement	Marine sandstone. Igneous intrusive rocks and shist.

* Idealized diagrammatic chart showing most of the important Cenozoic formations found in Los Angeles County in the eastern Ventura basin and Soledad basin, with their ages and general lithology. Data adapted from various sources including Jahns, 1940; Kew, 1924; Laiming, 1952; Miller, 1934; Oakeshott, 1954a; Sheller, 1952; and Woodring, in Gale, 1933.

Santa Fe Springs Oil Field (Winter, 1943; Conservation Committee of California Oil Producers, 1952). The Santa Fe Springs field is about 5 miles southeast of the East Los Angeles field and about 12 miles southeast of downtown Los Angeles. Oil was discovered in 1919 but little attention was paid to the area until 1921 when a well was completed with an initial flow of about 2,500 barrels of oil a day. This discovery led to an intensive drilling campaign, and the production of the field mounted so rapidly that by 1923 it threatened to upset the entire price structure of the country. The Santa Fe Springs field ranks third in total production of oil in the Los Angeles basin, being surpassed only by Long Beach and Wilmington, in that order.

The surface of the field is nearly flat and is covered with alluvium, below which is about 7,000 feet of Pliocene shale, siltstone, sandstone, and conglomerate. In addition, several thousand feet of Miocene sediments, predominantly shale and sandstone, were penetrated in a well drilled to a depth of 11,314 feet.

A shallow gas zone at a depth of about 2,000 feet is of small commercial interest and caused disastrous blowouts when penetrated in drilling. Six distinct major oil zones are in lower Pliocene sandstone and range in depth from about 3,200 to 7,000 feet below sea level. The Foix zone at a depth of about 3,200 feet, was originally saturated for 183 feet; the Bell zone, at a depth of about 3,700 feet, is 315 feet thick; the Meyer zone, at a depth of 4,150 feet, contains 650 feet of oil-bearing sand; the Nordstrom zone, at a depth of 4,905 feet, was once productive over a 520-foot interval; the Buckbee zone, at a depth of about 5,600 feet, was productive over a 610-foot interval; and the O'Connell zone, at a depth of about 6,250 feet, is 930 feet thick. Three oil zones are in the upper Miocene Puente formation; the Clark zone is about 260 feet thick at a depth of about 7,150 feet; the Hathaway zone is about 300 feet thick with the top of the zone at a depth of about 7,450 feet; and the Patterson zone is about 60 feet thick and lies at a depth of about 7,800 feet.

The Santa Fe Springs field is on a flat elongated dome which has a closure of at least 400 feet. The long axis of the dome strikes approximately N. 70° W. Only minor faulting has been noted in the field, apparently restricted to the Meyer zone.

As of May 1, 1953, the Santa Fe Springs field has yielded 545,497,000 barrels of oil and 744,161 million cubic feet of gas from a proven area of about 1,000 acres. During April 1953, a total of 430,418 barrels of oil and 425 million cubic feet of gas were produced from 563 wells.

Other Fields. The Belmont, La Mirada, Leffingwell, Walnut, and Western Avenue oil fields have yielded about 139,000 barrels of oil to January 1, 1952. Insufficient geologic data regarding these fields preclude any detailed description in this report.

Eastern Ventura Basin

That part of the Tertiary basin which now constitutes the northwestern part of the Santa Monica Mountains and the easternmost Ventura basin, often called the Mint Canyon area, has been described in the section on geology, above. The following section deals primarily with that part of the eastern Ventura basin in Los Angeles County

which has yielded significant amounts of oil and gas. (See also Jahns. 1940; Putnam and Bailey, 1942; Rand, 1951).

Much of the Ventura basin in Los Angeles County is now a mountainous region, highly folded and faulted, its broad topographic outlines having been formed in upper Pleistocene to Recent time. Oil and gas have accumulated in Pliocene, Miocene, and Eocene sediments in order of decreasing yield, respectively. The specific structural features that have controlled this accumulation in known oil fields are described in the following section, in which oil fields are arranged alphabetically.

Aliso Canyon Oil Field (Leach, 1947; Holston, 1952). The Aliso Canyon field, discovered in 1938, is near the southeastern border of the Ventura basin and lies approximately 30 miles northwest of downtown Los Angeles. The field is on the deeply eroded south slope of the Santa Susana Mountains, north of the surface trace of the Santa Susana thrust fault.

An incomplete section of sediments ranging in age from Cretaceous (?) to Pliocene has been found in the field. Late Pliocene and Pleistocene formations formerly present in the area have been removed by erosion and by displacement along the Santa Susana thrust fault, which trends approximately west through the area. The stratigraphic section south of the Santa Susana fault consists of at least 4,000 feet of upper Pliocene (upper Pico) unconsolidated, poorly sorted sand and gravel; about 1,000 feet of lower Pico thick bedded siltstone and sandstone; about 500 feet of lower Pliocene (Repetto) siltstone with fine-grained sandstone interbeds; several hundred feet of upper Miocene (Modelo) diatomaceous siltstone, shale, and foraminiferal siltstone with thin arenaceous limestone beds; several hundred feet of middle Miocene (Topanga ?) sandstone, conglomerate, and thin shale; a massive biotitic sand member of possible Oligocene age, called the Osila sand member; alternate shale, sandstone, and conglomerate of Eocene age; and Cretaceous (?) massive biotitic sandstone with thin shale interbeds.

Several oil zones of commercial interest have been found in the Aliso Canyon field. The Aliso zone, at a depth of about 3,700 feet below the surface, has a maximum thickness of about 160 feet, and the Porter zone at a depth of about 4,750 feet, has a maximum thickness of 700 feet. Both of these zones are in Pico formation sandstone (upper Pliocene). The Sesnon zone, at depths ranging from 6,900 to 7,800 feet below the surface, and the Del Aliso zone above it, are in sandstone of Miocene age. Some oil was discovered from the Frew zone of Eocene age but the pool has been abandoned.

The complicated structure in the Aliso Canyon field was the result of post-Pliocene deformation. Two thrust faults, known as the Ward and Frew faults, were developed before the north-dipping Santa Susana thrust fault placed middle Miocene Topanga (?) sandstone above upper Pliocene Pico sediments. The final stage in the deformation was a general arching. The productive portion of the field is in a graben formed between the Ward and Frew faults.

As of May 1, 1953, the Aliso Canyon field has yielded 16,993,000 barrels of oil and about 20,786 million cubic feet of gas from a proven area of 880 acres. In April 1953, the field yielded 215,446 barrels of oil and 566 million cubic feet of gas from 89 wells.

Castaic Hills Oil Field (Roth, 1952). The Castaic Hills field is located along U. S. Highway 99 and in the adjacent hills approximately a mile south of the town of Castaic. The discovery well was completed in September 1951.

The general geologic section consists of: (1) 1,400 to 2,700 feet of conglomerate, sand, clay, of the nonmarine Saugus formation of lower Pleistocene-Pliocene age; (2) 1,000 to 1,400 feet of conglomerate, sand, and siltstone of the marine Pliocene Pico formation, at the base of which some Repetto (lower Pliocene) sediments may be present; (3) 6,500 feet of Modelo (upper and middle Miocene) sand, conglomerate, and shale of which there are: (a) 50 to 200 feet of Delmontian conglomerate and siltstone; (b) 1,700 to 2,500 feet of upper Mohnian conglomerate and sand; (c) 4,500 feet of lower Mohnian shale, conglomerate, and thin sand beds.

One productive zone, called the Sterling zone, ranges in thickness from 30 to 220 feet and occurs in the Modelo formation (uppermost lower Mohnian stage) at a depth of about 4,650 feet. Non-productive tar sands have been penetrated in the Saugus and Pico formations.

The field is on the steeply dipping south flank of a westward-trending anticline known as the Loma Verde anticline. The western limit of production is provided by facies change; to the east, closure is effected by faults probably related to the San Gabriel fault; and closure to the north is provided by both faulting and facies change. Several faults in the field divide it into a number of fault blocks.

As of May 1, 1953, thirty-eight wells were completed in the area, resulting in a cumulative production of 1,613,000 barrels of oil and 2,401 million cubic feet of gas. In April 1953 a yield of 102,739 barrels of oil and 191 million cubic feet of gas was obtained from about 280 proven acres.

Castaic Junction Oil Field (Musser, 1952, p. 30; Yarborough and Bear, 1952). The Castaic Junction field, southwest and south of Castaic Junction, on U. S. Highway 99 south of the town of Castaic, was discovered in January 1950. At the end of 1951 the field was about 2 miles long and one-third of a mile wide.

Pliocene and Miocene sands of the area are highly lenticular in nature. The general geologic section consists of: (1) 3,300 to 7,000 feet of nonmarine Saugus (lower Pleistocene-Pliocene) conglomerate, sand, and clay; (2) 1,500 to 3,400 feet of marine Pico and Repetto (Pliocene) conglomerate, sand, and siltstone; (3) 4,200+ feet of Modelo (upper and middle Miocene) sand, conglomerate, and shale. The discovery well found a continuous upper Miocene shale section from 8,000 to 10,900 feet.

Three producing zones have been found. Reservoir 21, the deepest zone and the first to be discovered, is encountered in Miocene sandstone at a depth of about 11,700 feet below the earth's surface. In December 1950 a new pool was discovered in the interval 9,745 to 9,880 feet at the approximate contact between rocks of the Delmontian and Mohnian stages of the upper Miocene epoch. Designated as Reservoir 10, it has proved to be the most prolific oil zone in the Castaic Junction field. In August 1951 a well encountered a new zone, Reservoir 15, approximately 1,000 feet below the base of Reservoir 10.

The field lies on the southeastward plunging Del Valle anticline. Oil accumulation has been controlled by strong cross-faulting or by stratigraphic traps in lenticular sands.

In April 1953 production from 12 wells was 57,821 barrels of oil and 64 million cubic feet of gas. Individual wells have yielded from 450 to 750 barrels per day; each well, however, has been curtailed to an average of approximately 200 barrels per day for engineering purposes. As of May 1, 1953, the field has yielded 1,053,000 barrels of oil and 1,326 million cubic feet of gas.

Del Valle Oil Field (Knight, 1952; Nelson, L., 1952). The Del Valle field is about 5 miles west of the intersection of U. S. Highway 99 and State Highway 126, southwest of the town of Castaic. Most of this field lies in Los Angeles County; a small part is in Ventura County. The field was discovered in September 1940.

Stratigraphy in the area is as follows: (1) about 5,500 feet of Pliocene siltstone, sandstone, and conglomerate of marine origin (fossils indicate that some of the upper beds may have been deposited contemporaneously with the Saugus); (2) about 7,300 feet of upper Miocene sediments consisting of : (a) 3,600 feet of Delmontian and upper Mohnian brown and gray platy shale and siltstone with interbedded sand and conglomerate; (b) 3,700 feet of lower Mohnian hard brown and gray platy shale, commonly siliceous, with phosphatic material, and interbedded sandstone.

Ten oil zones have been discovered. All zones, except one in Pliocene sandstone, are in upper Miocene sandstone and conglomerate. Production is obtained from depths ranging from 5,000 feet to 10,000 feet below the surface. The deepest well drilled in the field bottomed in rocks of the lower Mohnian stage of the upper Miocene epoch at a depth of 13,018 feet.

The Del Valle oil field is located on the west-trending Del Valle anticline. Two major south-dipping trust faults, the Holser fault and the Del Valle fault, are associated with the anticline. Folding, faulting, and lensing of sands have provided oil traps.

Present production is from approximately 500 acres with 80 producing wells. Production during April 1953 was 84,495 barrels of oil and 458 million cubic feet of gas; total production to May 1, 1953 is 16,314,000 barrels of oil and 51,459 million cubic feet of gas.

Honor Rancho Oil Field (Bode and MacMillan, 1952). The Honor Rancho field is adjacent to U. S. Highway 99, about a mile north of its junction with State Highway 126. The field was discovered in August 1950. At the close of 1951 the field was half a mile long in an east-west direction and about 1,000 feet wide.

Rocks penetrated by wells in this field are Pleistocene, Pliocene, and Miocene in age. The uppermost 4,000 feet consist of sandstone, conglomerate, and sandy conglomerate with minor siltstone interbeds. The Saugus formation of lower Pleistocene-upper Pliocene age and the Pico formation of upper Pliocene age are contained in this section. A predominantly shaly section identifies the top of the lower Pliocene Repetto formation, which is about 800 feet thick in this area. Upper Miocene sandstone, conglomerate, and shale complete the section as known from the deepest well drilled to 8,951 feet below sea level.

Two commercial oil zones have been discovered in upper Miocene rocks. Discovery was made in the Rancho zone, which occurs in a sandstone as much as 500 feet thick at a depth of about 4,500 feet below sea level. In November 1950 the Wayside zone was brought into production from a depth of about 5,400 feet. This zone consists of over 100 feet of coarse-grained arkosic sandstone which grades downward into sandy conglomerate.

The Honor Rancho field lies along a westward-plunging anticline known as the Rancho anticline. The San Gabriel fault to the north and east and a syncline north of the Rancho anticline have controlled the accumulation of oil in the field.

In April 1953 production from 17 wells was 136,590 barrels of oil and 176 million cubic feet of gas. As of May 1, 1953, the field had yielded 2,008,000 barrels of oil and 2,002 million cubic feet of gas.

Newhall Oil Field (Arleth, 1947; Kew, 1943; Oakeshott, 1950b; Walling, 1934). The Newhall field is about 30 miles northwest of the city of Los Angeles. It is made up of two groups, the Newhall group and the Pico anticline group, each including several small productive fields. Six fields are on the Pico anticline, a major anticline southwest of Newhall, and five fields are on homoclinal structures east and southeast of Newhall. Another area included in the Newhall group yielded small amounts of oil from crystalline rocks.

(1) Pico Anticline Fields (East, Rice, Wiley, Towsley, De Witt and Pico Canyons). The Pico anticline is several miles southwest of the town of Newhall and about 1½ miles north of the Aliso Canyon oil field. The anticline trends northwest along the north flank of the Santa Susana Mountains from San Fernando Pass to just west of Pico Canyon, a distance of 9 miles. Oil seeps along this anticline were discovered about 1850 and serious development began in 1875.

The most westerly field along the Pico anticline is the Pico Canyon field. About 2 miles to the southeast is the De Witt Canyon field. A mile farther southeast is the Towsley Canyon field; another mile southeast is the Wiley Canyon field; and another mile southeast is the Rice Canyon field; the East Canyon field completes the group three-quarters of a mile still farther to the southeast. Only the Wiley, Towsley, and Pico fields were commercial. The total proved area is about 160 acres. The Pico Canyon field is the largest and covers about 95 acres; the other fields range in proved area from several acres to about 20 acres.

The Pliocene-Pleistocene Saugus formation, the Pliocene Pico formation, and the upper Miocene Modelo formation are well exposed along the Pico anticline. The Saugus formation is composed of irregularly sorted conglomerate and sand of nonmarine origin. Between Pico Canyon and the Santa Clara River to the north, the type section is 4,600 feet thick. The type section of the Pico formation in Pico Canyon includes beds comparable in age to the lower Pliocene Repetto formation of the Los Angeles basin. This section, as originally described, is about 4,800 feet thick and is made up largely of brownish-gray siltstone containing numerous small limonitic concretions and lenticular sandstone and conglomerate. An additional 1,900 feet of Pliocene shale, sandstone, and some conglomerate is below the "Pico" type section described above. The Pliocene rocks apparently lie conformably above

upper Miocene sediments of the Modelo formation on the north limb of the Pico anticline. As much has 4,500 feet of Modelo shale, sandstone, and conglomerate is present in the Santa Susana Mountains.

Production was secured principally from a few zones in the Modelo formation. Owing to the difficulty of drilling deep wells at the time the field was developed, most of the productive wells were less than 2,000 feet deep. Production rates were low; wells usually yielded from 5 to 50 barrels of oil per day, but a few wells in the Pico Canyon and Wiley Canyon fields are recorded to have produced 50 to 100 barrels per day. The best production has come from the western end of the Pico anticline.

The Pico anticline is a comparatively narrow fold with dips on the flanks of 40° or more. Several cross-faults of the normal type with displacements of as much as 500 feet cross the axis of the anticline.

In April 1953 the Pico Canyon field yielded 628 barrels of oil and 1 million cubic feet of gas from 10 wells and the Towsley Canyon field yielded 105 barrels of oil from five wells. The other fields have been abandoned. By 1953 the Pico anticline fields had yielded about 5,100,000 barrels of oil from about 150 wells.

(2) Newhall Group (Newhall Townsite, Whitney Canyon, Placerita Canyon, Elsmere, and Tunnel and Schist Areas). Adjacent to and east of the town of Newhall is the second group of fields included in the Newhall oil field. All were discovered about 1900, except the Newhall Townsite field, which was discovered in 1951.

The Newhall Townsite field is just east of the town of Newhall and the Placerita Canyon field is about 1½ miles farther east. The latter field is now included in the newly designated Placerita oil field. The schist area is in upper Placerita Canyon 2½ miles east of the new Placerita field. Just south of the Placerita field is the Whitney Canyon field; half a mile south and southwest of the Whitney Canyon field is the Elsmere field; and the Tunnel area is half a mile southwest of the Elsmere field. The proved area (excluding Placerita oil field) covers about 225 acres but only the Newhall Townsite field and the Tunnel area are active.

Recent alluvium as much as 100 feet thick covers stream bottoms in the several canyons of the Newhall district. An unconformity separates this alluvium from about 675 feet of upper Pleistocene alluvium, terrace gravel, and fanglomerate. Below a major unconformity is the lower Pleistocene-Pliocene Saugus formation composed of about 2,000 feet of light-colored continental sand, gravel, and thin beds of shale. Upper and middle Pliocene mudstone, sandstone, and conglomerate of the Pico formation range from several hundred to 3,000 feet in thickness. The Sunshine Ranch member is continental in origin. Several hundred feet of lower Pliocene siltstone, sandstone, and conglomerate of the Repetto formation are above a major unconformity, below which are several thousand feet of sandstone, claystone, mudstone, and conglomerate of upper Miocene age. More than 2,000 feet of well-indurated shale, sandstone and conglomerate of Eocene age and the basement complex of pre-Tertiary granitic and metasedimentary rocks complete the geologic section. All of the rocks described crop out in the Newhall area.

In contrast to the fields of the Pico anticline group which yield oil from zones in Miocene rocks, the Newhall group yields oil principally from zones in Pliocene sandstones. The Tunnel area also yields oil from

upper Miocene rocks, the schist area yields oil only from pre-Tertiary crystalline rocks, and the Whitney Canyon and Elsmere fields yield some light oil from Eocene rocks. Well depths are shallow and production is secured from zones commonly less than 1,500 feet deep. Oil produced from the schist area is believed to have migrated into pre-Tertiary granite, gneiss, and metasedimentary rocks from Eocene strata underlying the Saugus formation in the San Gabriel fault zone.

The structural features of the newly discovered Newhall Townsite field are not fully known. Kew (1943) believed that lenticularity of the beds may have been a controlling factor in the accumulation of oil in the Whitney Canyon field and that oil also may have migrated from Eocene beds into overlying Pliocene sandstone. Kew (1943) believed the oil of the Elsmere field was trapped in west-dipping beds against a fault which trends in a northwesterly direction along Elsmere Canyon. Structure in the Tunnel area is thought to be similar to that in the Elsmere field; the northwest-trending fault in the Tunnel area is along the canyon in which the old state highway is located.

In April 1953 the Newhall Townsite field yielded 577 barrels of oil from two wells and the Tunnel area yielded 11,009 barrels of oil from 21 wells. Total oil production from both groups in the Newhall field (excluding the Placerita oil field) as of May 1, 1953, was 7,024,000 barrels.

Newhall-Potrero Oil Field (Loofbourow, 1952; 1952a). The Newhall-Potrero field is in the northern foothills of the Santa Susana Mountains approximately 6 miles northwest of the town of Newhall. It lies south of the Del Valle and Castaic Junction oil fields and about 1½ miles north of the Pico Canyon oil field. The discovery well was completed in August 1936.

The strata exposed on the surface in the Newhall-Potrero field are mainly upper Pliocene sediments of the Pico formation. Overlying the Pico formation on the north flank are continental sand and gravel of the Saugus formation of upper Pliocene and lower Pleistocene age. Miocene sediments are encountered in wells at depths ranging from 4,500 to 6,500 feet below sea level (average elevation of field is about 1,200 feet above sea level). To date, no wells have pentrated below upper Miocene strata, the total stratigraphic penetration ranging from 4,500 to 5,000 feet.

Seven oil zones are all within upper Miocene sandstone and conglomerate. The First zone, maximum thickness about 375 feet, is usually found about 300 feet below the top of the Miocene series. The Second zone is about 50 feet below the First zone and attains a maximum thickness of 340 feet in the southeast end of the field. The Third zone, with a maximum thickness of 400 feet, has yielded more than half of the total oil production in the field. Its top is approximately 1,000 feet below the top of the Miocene series. The Fifth zone occurs at depths ranging from 8,000 to 10,300 feet and reaches a maximum thickness in excess of 500 feet. The Sixth zone is about 400 feet below the base of the Fifth zone and reaches a maximum thickness of 400 feet. The Seventh zone is some 400 feet beneath the Sixth and is about 250 feet thick. The Ninth zone, consisting of interbedded hard cemented sandstone, siltstone, and shale, is about 500 feet below the Seventh zone and is at least 2,700 feet thick. A well in the Newhall-Potrero field, which yielded oil recently from the

Ninth zone in the interval 13,936 to 14,501 feet, is one of the deepest producing wells in the world.

A long, narrow, asymmetrical, northwest-plunging anticline strikes about N. 55° W. through the field. Numerous reverse-type cross faults, which have displacements of from 50 to 300 feet and which trend nearly west, have been encountered below the surface. In general these faults appear to have had little effect on the accumulation of oil.

As of May 1, 1953, the Newhall-Potrero field has yielded 29,651,000 barrels of oil and 29,385 million cubic feet of gas from an area of 1,025 acres. In April 1953, ninety wells yielded 263,407 barrels of oil and 1,034 million cubic feet of gas.

Oak Canyon Oil Field (Hodges and Murray-Aaron, 1943; Bell, 1952; 1947). The Oak Canyon field is about 3 miles north of the Del Valle oil field and 14 miles northwest of the town of Newhall. It lies in rugged hills at elevations ranging from 1,500 to 2,000 feet. The field was discovered early in 1941.

Sediments penetrated by wells in the Oak Canyon field range in age from Pliocene to upper Miocene. The upper 1,000 to 1,300 feet of strata are Pliocene coarse-grained sandstone and conglomerate and lenses of fine-grained silty sand. Unconformably below the Pliocene beds are about 2,000 feet of upper Miocene rocks of the Delmontian stage, consisting of grayish-brown laminated sandy shale interbedded with soft, fine sand, conglomeratic sand, and conglomerate. Underlying these rocks are as much as 6,300 feet of sediments of the Mohnian stage, consisting of grayish-brown laminated sandy shale, light to dark, brown siltstone, numerous thick bodies of fine- to medium-grained sand, carbonaceous material, and bentonite. Below these sediments a well penetrated 2,000 feet of middle Miocene rocks of the Luisian stage, consisting of grayish-brown siltstone, chocolate-brown siliceous shale, rapidly alternating sandy shale and gray sand, and several thick bodies of gray fine- to coarse-grained sand.

All oil zones in the field are confined to Miocene rocks. Zones are numbered from 1 to 8, excluding number 2, and range in thickness from about 75 feet to 600 feet. The top of the 1A zone is about 2,700 feet below the surface and the top of the 8B or lowest zone is at a depth of about 9,700 feet. The 5A zone, at a depth of about 6,900 feet, has yielded and is yielding more than half of the total oil and gas produced.

The field is on a plunging anticlinal fold that forms a ridge of hills which extend for over 5 miles in a southeasterly direction from Oak Canyon. Oil and gas have been trapped in a small dome, which is apparently a secondary fold on the larger anticlinal structure. Thrust faulting in the area also has had some influence in controlling the accumulation of oil.

As of May 1, 1953, the Oak Canyon field has yielded 6,075,000 barrels of oil and about 8,000 million cubic feet of gas. In April 1953 yields of 40,273 barrels of oil and 67 million cubic feet of gas were obtained from 20 wells.

Placerita Oil Field (Willis, 1952; Oakeshott, 1950b). The Placerita field lies along and adjacent to Placerita Canyon about 2 miles east of the center of the town of Newhall. The Placerita Canyon area of the Placerita field, previously included in the Newhall oil field, was dis-

covered in 1920. Development of the Placerita Canyon area proceeded slowly owing to the low gravity of oil encountered. In 1948 a higher gravity oil pool was discovered north of the Placerita Canyon area and in 1949 the entire area was designated as the Placerita oil field.

Spacing of wells in the new field was originally restricted to one per acre according to the provisions of the Spacing Act.* This act, however, was declared unconstitutional in September 1949, leading to one of the most intensive drilling campaigns ever witnessed in any California oil field.

Recent sand and gravel cover stream bottoms in Placerita Canyon and other canyons to the north. Upper Pleistocene alluvium, terrace gravel, and fanglomerate, which may be as much as 175 feet thick, cover much of the area near Placerita Canyon. Pliocene, Miocene, and pre-Tertiary granite, gneiss, and metasedimentary rocks crop out in the area. A subsurface stratigraphic section shows more than 1,800 feet of lower Pleistocene continental sand and gravel of the Saugus formation, a maximum of 1,400 feet of Pliocene conglomerate, sandstone, mudstone, and siltstone, more than 1,500 feet of Miocene marine and continental sediments of the Modelo formation, over 2,000 feet of shale, sandstone, and conglomerate of Eocene age (Las Llajas formation ?) and the pre-Eocene basement complex.

Two oil zones, the upper and lower Kraft zones, are in Pliocene sandstone. These zones range in thickness from a few feet to more than 480 feet and are at depths ranging from a few hundred to at least 2,300 feet.

The Placerita field is on a poorly defined anticlinal nose, flattened to little more than a west-northwestward-dipping homocline at depth. Closure is against the San Gabriel fault zone on the north and the Whitney Canyon fault on the east. Up-dip lensing, cross-bedding, and minor unconformities have also assisted in the formation of traps for oil.

As of May 1, 1953, the Placerita field has yielded 19,348,000 barrels of oil and 6,513 million cubic feet of gas from a proven acreage of about 600 acres. In April 1953 the field yielded 242,597 barrels of oil and 31 million cubic feet of gas from 326 wells.

Ramona Oil Field (Driggs, 1951). The Ramona field straddles the Los Angeles-Ventura County line. Approximately 65 percent of its producing oil wells are in Ventura County, although 310 acres of a total proved acreage of 575 acres are in Los Angeles County. The field is about 40 miles northwest of the city of Los Angeles and less than a mile northwest of the Del Valle oil field. The terrain is mountainous and it is often necessary to drill wells directionally. A well drilled in 1943 which yielded oil from the field was considered as extending the limits of the Del Valle fields considerably to the west and was not classed as a discovery well at the time.

Formations penetrated by wells in the Ramona field range from Pico beds of upper Pliocene age to Mohnian sediments of the Miocene epoch. As much as 1,000 feet of Pico marine beds, consisting of light-colored gravel and conglomerate, blue-gray clay shale and brown massive shale intercalated with beds of coarse sand, silty sand, and sandstone con-

* Sections 3600-3608, Public Resources Code of the State of California.

stitute the upper part of the section. Below are 500 to 1,200 feet of siltstone and claystone with interbedded sand and conglomerate assigned to the Repetto formation of lower Pliocene age. The Delmontian stage of the Miocene epoch is represented by 1,800 to 2,200 feet of dark gray to brown, hard, massive to platy shale, sandstone, and medium- to coarse-grained sand that grades in places to conglomerate. Below these rocks are at least 360 feet of marine deposits of the Mohnian stage of the Miocene epoch consisting of almost equal amounts of shale and sand.

All three productive oil zones of the field are in Delmontian sediments. The Black zone lies just below the Pliocene-Miocene contact and is about 600 feet below sea level or about 2,000 feet below the earth's surface at the top of the structure. The zone consists of two bodies of from poorly sorted to well-sorted, fine-grained conglomeratic sand separated by a thin body of shale. The total thickness ranges from 80 to 150 feet in the westerly portion of the field to about 400 feet at the easterly end. The Kern zone at its highest point is about 1,000 feet below the Pliocene-Miocene contact. The overall thickness of this zone ranges from 200 to 500 feet. The Del Valle zone lies just above sediments of the upper Mohnian stage of the Miocene epoch. The average thickness of this zone ranges between 400 and 1,500 feet.

The major portion of the Ramona field is on the southwest flank of the northeast-plunging Ramona anticline. This structure is developed on the upthrown block of the Holser reverse fault which strikes N. 73° E. and dips 65° SE.

As of May 1, 1953, the Ramona oil field has yielded 9,741,000 barrels of oil and 10,431 million cubic feet of gas. Production during April 1953 totaled 91,202 barrels of oil and 222 million cubic feet of gas from 122 wells.

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TABULATED INDEX OF MINES AND MINERAL DEPOSITS IN LOS ANGELES COUNTY

Various sources, both published and unpublished have contributed data in the following tabulation, which presents a summary of the most reliable information known to the authors. Like the preceding text, the tabulation is separated into metallic and nonmetallic mineral deposits, in that order.

Numbers in the first column correspond to numbers that locate the deposits on the mineral deposit map, in pocket; unnumbered deposits are not located. In parentheses after the preferred name are listed synonyms which appear elsewhere in the list as cross references. Ownership data are believed to be accurate as of the time the report was written. In the column "Location" a question mark indicates the section is not certainly known, the abbreviation "approx." indicates the township is in doubt, and "proj." indicates that the public land survey is incomplete on the base map in that vicinity.

In the last column, in parentheses, appear references to publications listed in the accompanying bibliography. The name listed is that of the senior author; the number preceding the colon is the year of the publication; that following the colon is the page reference. Succeeding references by the same and other authors are separated by semicolons. A description in the text of this report is indicated by the expression "herein."

METALS

ANTIMONY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Ore Hill (Denver)						See in lead-silver-zinc section. (Aubury 06:359; Sampson 37:174; Tucker 21:318; 27:288.)

CHROMITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Acton deposit	Undetermined	36?	5N	13W	SB	Near Acton station. Details undetermined. No development or production. Possibly ilmenite mis-identified as chromite. (Bradley 18:151; Merrill 19:471; Murdoch 48:104; Oakeshott 37:243; Sampson 37:175; Tucker 27:288.)
	Evert deposit	Nick Evert, 1027 W. 16th St., Los Angeles (1919)	3?	5N	12W	SB	One mile west of Harold. Details undetermined. No development or production. Possibly ilmenite mis-identified as chromite. (Bradley 18:151; Merrill 19:471; Murdoch 48:104; Oakeshott 37:243; Sampson 37:175; Tucker 27:288.)
	Bouquet Canyon deposit	Undetermined	Approx	6N	15W	SB	Ridge north of Bouquet Canyon, 13 miles north of Saugus. Float boulders of chromite weighing as much as 100 lbs. in a northeast-trending zone of serpentinized peridotite. No ore found in place. Reported to carry 42% Cr_2O_3. Prospected 1918. No production. Idle. (Murdoch 48:104; Oakeshott 37:243; Sampson 37:175; Tucker 27:288.)
	Little Tujunga quadrangle occurrences	Undetermined		Undetermined			Little Tujunga quadrangle, western San Gabriel Mts. Two specimens of basic gabbro contain 17 and 47% chromite as a primary constituent. No exploration or mining attempted. (Oakeshott 37:243.)

COBALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Kelsey						See in lead-silver-zinc section. (Storms 93:244-245; Tucker 27:315-316.)
	Ore Hill (Denver)						See in lead-silver-zinc section. (Sampson 37:175; Tucker 27:288.)

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Big Horn						See in gold section. (Eric 48:259.)
	Big Susanna						See Rogers and Gentry in gold section. (Eric 48:259.)
	Black Mountain	J.L. Watts, Lancaster (1937)	Undetermined				Black Mt., 27 miles southeast of Lancaster. Series of parallel veins 1-2 ft. wide in gneiss. Veins reported to carry 2-7% copper as malachite and $3-7 in gold and silver. Explored by several shafts 10-15 ft. deep. No production. Long idle. (Sampson 37:175; Tucker 27:289.)
	Clearwater	Arthur R. Plumb, Los Angeles	21	6N	15W	SB	Clearwater Canyon, about 12 miles north of Saugus. Copper carbonates in fractured hornblende schist enclosed in gneissoid granite. Developed by open cuts and 100-ft. crosscut, exposing small lenses of copper carbonates carrying 0.5-2.0% copper. Idle. (Eric 48:259; Sampson 37:175-176.)
	Conover						See Emma. (Eric 48:259.)
	Denver						See Ore Hill group in lead-silver-zinc section. (Eric 48:259; Sampson 37:176; Tucker 21:318; 27:289-290.)
1	Emma (Conover, Parker Mountain)	Bournite Mining Co., Los Angeles (1943). Operated by Emma Consolidated Mining Co. (1889).	11	4N	13W	SB	South side of Parker Mt., 1½ miles southwest of Acton. Irregular quartz veins up to 6 ft. wide, with copper, silver and gold, in disintegrated biotite diorite and anorthosite. Adits 500 and 100 ft. long; shafts, two 75 ft., two 40 ft., one 35 ft. deep. Leaching operation carried on in 1926 on 1-2% copper ore. Machinery and track removed except for ore bin and leaching vats. Reported inactive since 1900 except for brief ventures in 1926 and 1944. Idle. (Eric 48:259; Merrill 19:472; Preston 90a:194-195; Sampson 37:176; Tucker 27:290-291.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Free Cuba	Ira L. Houser, Acton (1919)	1	4N	13W	SB	Half a mile south of railroad station at Acton. Copper in 20-ft. quartz vein in granite. Worked about 1860 and then abandoned. Native copper found later at 200-ft. depth in old shaft. Production undetermined. Long idle. (Aubury 05:261; 08:346; Eric 48:259; Merrill 19:471.)
	Governor (New York)						See in gold section. (Eric 48:259.)
	King of the West	R.E. Nickel, Acton (1936)	1	4N	13W	SB	Parker Mt., 1 mile south of Acton. Four ft. quartz vein in granite carries malachite, bornite, and gold and silver values. Developed by 150-ft. vertical shafts on vein and several shallow shafts. Long idle. (Eric 48:260; Sampson 37:176; Tucker 27:290.)
	Mooney and Williams	Mooney and Williams Acton (1908)	12	4N	13W	SB	Parker Mt., about 2 miles south of Acton. Copper ore in quartz vein in granite. Long idle. (Aubury 05:261; 08:346; Eric 48:260; Merrill 19:472.)
	New York						See Governor in gold section. (Eric 48:260.)
	Palm Development Co.	E.M. Ross and Joseph H. Call, Los Angeles (1919)	30	5N	10W	SB	North side of San Gabriel Mts., about 11 miles southeast of Palmdale. Porphyritic dike traceable for about $1\frac{1}{2}$ miles, averaging 180 ft. in width, contained malachite and carried gold and silver. Three shafts, 12, 70, and 125 ft. deep, sunk prior to 1919. Long idle. (Aubury 05:261; 08:346; Eric 48:260; Merrill 19:471; Sampson 37:175; Tucker 27:289.)
	Parker Mountain						See Emma. (Eric 48:259; Sampson 37:176; Tucker 27:290-291.)
	Santa Catalina Island deposits	Santa Catalina Island Co., Avalon (1952)	23?	8S	16W	SB proj.	Cherry Valley Harbor, Santa Catalina Island. Argetiferous galena and copper sulfides in 4-ft. vein dipping vertically. Explored by 142-ft. drift. Production undetermined.

COPPER (Cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Santa Catalina Island deposits(continued)						Long idle. (Eric 48:260; Preston 90b:280; Sampson 37:175; Tucker 27:291.)
	Silver Mountain	E. Morgan, 3216 Tyburn St., Los Angeles (1937)	31?	2N	9W	SB	San Gabriel River, about 8 miles north of Azusa. Vein 1½-3 ft. wide reported to carry 4-6% copper, 20-40 ounces of silver, $3 in gold. Explored by 40-ft. crosscut to vein. Idle. (Eric 48:260; Sampson 37:176.)
	Winter Creek	O.L. Roberts, Roberts Camp (1937)	3	1N	11W	SB	Santa Anita Creek, about 5 miles north of Sierra Madre. Two quartz veins, 1-3 ft. wide and 100 ft. apart, cut granite and diorite and carry chalcopyrite, bornite, pyrite, gold, silver, and molybdenite. Surface samples reported to carry 10-15% copper, $2-8 in gold, 1-80 ounces of silver, and 0.5-1% molybdenite. One vein explored by 170-ft. crosscut with 100-ft. drift and 40-ft. adit. Second vein explored by 80-ft. adit and, 30 ft. above it, a 50-ft. adit which encountered azurite and malachite in addition to the minerals listed above. Production undetermined. Idle. (Eric 48:260; Sampson 37:176-177.)

GOLD

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
2	Acme	Undetermined	1	3N	15W	SB	Bear Canyon, $6\frac{1}{2}$ airline miles north of San Fernando. Veins in metamorphic rocks of San Gabriel complex explored by underground workings of undetermined extent. Production undetermined. Idle since 1940.
3	Alexander	John Alexander (1948)	12	3N	14W	SB	Pacoima Canyon, $8\frac{1}{2}$ airline miles northeast of San Fernando. Shaft sunk 40 ft. on quartz vein in San Gabriel metamorphic complex in 1948. No production. Idle since 1948.
4	Allen and Bailey	J.O. Frazer. Leased to R.A. Allen, Glendale (1937)	14	5N	16W	SB	San Francisquito Canyon, 8 miles north of Saugus. Auriferous bench gravel. Hydraulicked in 1932 with water pumped from creek bed. Idle since. (Sampson 37:178.)
5	Allison	Milton S. Carey, Rt. 2, Box 54-B1, Little Rock	8	2N	8W	SB	Allison Gulch, East Fork of San Gabriel River, about 4 airline miles northeast of Camp Bonita. Discontinuous, moderately dipping quartz stringers, up to 2 ft. wide, in schistosity of meta-andesite, extensively fractured and oxidized. Operated by surface workings and irregular tunnels up to 250 ft. long; stopes no longer safely accessible. From 1934 to 1944 over 10,000 tons of ore were treated yielding nearly $50,000 in gold. Mill, including jaw crusher and ball mill, inoperative and workings idle when visited in 1952. (Merrill 19:477; Sampson 37:178; Tucker 27:292.)
	Atlanta						See Big Horn (Sampson 37:194, map.)
	Azusa Rock & Sand Co.						See San Gabriel Valley placers.
6	Baldora	M.S. Blair, 1428 N. Spadra, Fullerton. Leased (1949) to Livingston Greenwood, 3433 W. 64th St., Seattle	10	2N	8W	SB	Dry Gulch, off Coldwater Canyon, about $3\frac{1}{2}$ miles southwest of Old Baldy Peak. Discontinuous quartz stringers up to 2 inches wide dip gently southwestward in schistosity of chloritic schist near zone intruded by irregular porphyritic diorite sills. Explored by open cuts and several

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
6	Baldora (continued)	Washington					hundred ft. of adits, now partly caved. Over a thousand tons of ore treated 1935-1940 yielded over $5,000 in gold; during most recent activity (1949) 40 tons of ore yielded about $100 in gold. Machinery removed, property idle since 1949.
7	Baldwin	William G. Marr, 1641 Chase St., Van Nuys (1951)	25,26	5N	15W	SB	Upper Vasquez Canyon, 9 airline miles northeast of Saugus. Vein explored by underground workings of undetermined extent. Production undetermined. Idle.
8	Bear Canyon	C.F. Guthridge, 325 Central Bldg., Los Angeles (1937)	16	4N	14W	SB	Mouth of Bear Canyon, 2 miles east of Lang. Placer location in river alluvium. Production undetermined. Long idle. (Sampson 37:194, map.)
9	Big Chief	Louis B. Crago, 38 W. Mountain View, No. Long Beach	34	8N	16W	SB	Neenach district, 4 miles southeast of Neenach school. Gold-bearing pegmatoid vein dips 60° southeastward, in faulted zone in decomposed granite. Developed by 90-ft. adit, about 150 ft. of drifts and stopes. About $2,000 in gold produced in early 1920's. Long idle.
10	Big Horn (includes Atlanta, Called Back, Del Norte, Katahdin & Ontario, and Milwaukee)	Mrs. F.C. Fenner, 1017 W. Lake, Los Angeles. Leased to Vincent M. Burnhart, Supt., American Metal Co., Ltd., New York (1937)	7,8	3N	8W	SB	North Baldy Mt., 28 miles east of Palmdale, 9 miles from Valyermo. Quartz vein 25 ft. wide discontinuously exposed for about 2,500 ft. in schist and gneiss. Developed by 6 adits totalling over 4,000 ft. in length. Reported yield of nearly $40,000 in gold 1904-1906; average $2.55 per ton. Fifty-ton flotation mill operated in 1934. Idle since 1936. (Crawford 96:203; Merrill 19:477; Sampson 37:178-179; Tucker 27:292; 34:318.)
	Big Susanna vein	W.J. Rogers and Thomas Gentry, Fairmont. Leased to Fred H. Spence, Lancaster (1942).					See Rogers & Gentry.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
11	Black Cargo	C.C. Schey and P.N. Maynard, Route 3, Box 100, Palmdale	13	3N	12W	SB proj.	Central San Gabriel Mts., near Monte Cristo mine. (Phipps 51; herein.)
	Black Cat	Pierson, Bell & Stamp (1896)	Undetermined				Ten miles east of Acton. Developed by 2,000 ft. of workings. Twenty-stamp water-power mill. Production undetermined. Active in 1896. Long idle. (Crawford 96:203.)
	Black Hawk group	John and Edna De Shazo, 449 N. Gardner, Los Angeles (1937)	35?	8N	17W	SB	Cow Springs Canyon, $4\frac{1}{2}$ miles east of Sandbergs. Narrow, gently dipping veins in faulted granitic rock explored by 50-ft. tunnel and 20-ft. winze. No commercial ore. Idle since 1937. (Sampson 37:179.)
	Blue Goose	Floyd Plumb, Acton, operator (1940)	21?	5N	13W	SB	Acton district, near Puritan mine, about 4 airline miles northwest of Acton. Development reported 1940 but no production. Long idle.
12	Bradshaw lease	Mrs. Etta Mae Timm, P.O. Box 10, Acton (1952). Leased to R.C. Bradshaw and associates (1937)	23	5N	13W	SB	Between Governor and Red Rover mines, about $2\frac{1}{2}$ airline miles northwest of Acton. Quartz vein in sheared, altered diorite unsuccessfully sought by 300-ft. crosscut towards Governor vein. Active 1937-1940 with undetermined production. Idle since 1940. (Sampson 37:179.)
13	Brite lease	W.J. Rogers and Thomas Gentry, Fairmont (1937). Leased to Brite (1937). Operated by Russell and Myler under Ventura-Neenach lease (1940)	26,27	8N	16W	SB	Neenach district; southeast continuation of Rogers and Gentry vein, which see. Quartz vein 2-5 ft. wide in decomposed pegmatoid diorite. Yielded over $35,000, averaging $40 per ton from oreshoot 185 ft. long within 100 ft. of surface. Developed through 80-ft. shaft inclined about 75° southward on vein, and 200 ft. of level workings. Inactive since before 1940. (See also Ventura-Neenach.) (Sampson 37:179; Tucker 34:319.)
	Buena Esperanza	W.L. Hastings, Acton (1896)	Approx	5N	13W	SB	About 2 miles northwest of Acton. Explored by 3 shafts, 50,80, and 30 ft. deep. Active 1896; production undeter-

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Buena Esperanza (cont'd)						mined. Long idle. (Crawford 96:203.)
	Cahuenga	Cahuenga Mining and Irrigation Co. H.J. Lloyd, sec., 428 Byrne Bldg., Los Angeles (1896)	Approx.	1S	14W	SB	Seven miles north of Los Angeles near Cahuenga Pass (?) Explored by 4 adits 30-75 ft. long and two 20-ft. shafts. No production. Long idle. (Crawford 96:203; Merrill 19:477.)
	Called Back						See Big Horn. (Crawford 96:203; Merrill 19:477.)
14	Campbell-Dunkes group	Arthur J. Campbell and Joe Dunkes, Rt. 1, Box 299, Sand Canyon Rd., Saugus (1951)	4	3N	14W	SB proj.	Upper Sand Canyon, 7 miles northeast of San Fernando. Quartz veins in basic metamorphic rocks of San Gabriel complex. Explored by shallow workings. No production. Idle.
	Canyon						See Lost Canyon. (Laizure 34:248-249.)
	Casa Grande	Undetermined	31?	4N	12W	SB	Northeast slope of Mt. Gleason, about 6 miles south of Acton, near Mt. Gleason mine. (Merrill 19:476-477; Preston 90a:195, 196.)
	Castaic-Newhall area placers						Foothill canyons and valleys of area near Castaic and Newhall, scene of widespread placer mining since the 1830's. Activities centered in Bouquet, Casteca (Castaic), Cave, Dry, Haskell, Palomas, Placerita, San Francisquito, Santa Felicia (San Filiciana, etc.), Sheep, and Soledad Canyons. Little mining activity since 1930's. (Crawford 94:152; Cutter 48:13; Goodyear 88:333-335; Merrill 19:473-475; Preston 90a:201-204; Sampson 37:177,179-181, 183,191,192, 193; Simpson 34:407,409; Storms 93:248; Tucker 27:291, 295; herein.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
15	Champion (Enterprise, Utopia)	A. Thomasson, Rt. 1, Box 102, Saugus. Leased to Daniel Webster et al., 14906 Lemoli Ave., Gardena (1953)	21,28, 29	5N	14W	SB	About 11 miles west of Acton. Four parallel quartz veins 2-4 ft. wide cut granitic rock. Ore oxidized above 50-ft. depth. Assay of 0.55 oz. gold per ton reported. Developed by 540- and 290-ft. adits, 135- and 80-ft. shafts, and about 1,000 ft. of other workings. Production undetermined. Idle since World War I. Under lease in 1953 for production of graphite. (See in graphite section.) (Sampson 37:179; Tucker 27:292.)
	Chuckawala						See Stanley.
	Conroy Ranch						See Soledad Placer Co. (Sampson 37:192.)
	Cornet	T.H. Webb, New York (1896)	Approx	5N	13W	SB	About 4 miles northwest of Acton. Explored by two 250-ft. tunnels and 40-ft. shaft. Production undetermined. Long idle. (Crawford 96:203.)
16	Crail & Zanteson	Charles Crail, R.A. Zanteson, 258 S. Vendome St., Los Angeles	20	4N	14W	SB	Pole Canyon, about 1 mile south of Lang station. Quartz vein 3 ft. wide, traceable 1/4 mile, carries sulfide minerals reported to assay $5-$35 per ton in gold. Developed by 30- and 12-ft. adits. No production. Idle.
	Cruzan						See Lost Canyon. (Sampson 37:179, 181; Tucker 27:292.)
17	Dawn	Mrs. C. Zengel, 1452 Dana St., Los Angeles 7. Leased to A.V. Herr, 5176 Hollywood Blvd., Hollywood (1953)	27	2N	12W	SB proj.	Millard Canyon, on southwest slope of Mt. Lowe, 6 miles north of Altadena. Vertical quartz vein 3-5 ft. wide in faulted granitic rock carries iron sulfides, chalcopyrite and free gold. Developed by about 900 ft. of level workings on 2 levels and about 100 ft. of raises and winzes. Open stope 3-6 ft. wide, 60-70 ft. long, and 80 ft. high timbered in part with square sets. Mill included roll crusher and two tables. Production undetermined. Idle since 1937; buildings destroyed. (Merrill 19:477; Sampson 37:181; Tucker 27:292-293.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Del Norte						See Big Horn. (Sampson 37:194, map.)
	Denver Mining and Milling Co.						See Ore Hill Group in lead-silver-zinc section. (Sampson 37:176; Tucker 21:318; 27:288,289-290.)
	Dewey group	I. Dewey, Glendale	Undetermined				Southeast slope of Mt. Gleason, near headwaters of Mill Creek, 8 miles south of Acton. Developed by shaft and tunnels. Idle since 1927. (Sampson 37:181; Tucker 27:293)
	Don						See Hi-Grade. (Sampson 37:181-183.)
	Dot						See Holly.
18	Double Eagle (Gray Eagle)	J.C. Nimmo and F.W. Kent, Saugus (1937)	21	6N	14W	SB	About 19 miles northeast of Saugus, on the Bouquet Canyon-Elizabeth Lake road. Series of parallel oxidized quartz veins 1-3 ft. wide, dips 40-65° in quartz monzonite. Reported to carry \$8-\$10 per ton in gold with a little pyrite. Developed by 125-ft. inclined shaft and about 1,200 ft. of drifts and crosscuts. Twenty-ton mill active in 1927. Production undetermined. Inactive since 1931. (Sampson 37:183; Simpson 34:407; Tucker 27:293.)
19	Dry Canyon lease	Soledad Placer Co. Leased to Marsons Gold Co., M. Wilson, pres., La Canada (1937).	2	4N	16W	SB	Conroy Ranch, Dry Canyon, about $3\frac{1}{2}$ miles north of Saugus. Auriferous gravels 15-30 ft. deep mined with power shovel treated with drag classifier, Ainley bowels. Reported 6 oz. recovered daily by 5 employees. Total production undetermined. Inactive since prior to 1937. (Sampson 37:183.)
	Dutch Louie						See G.C.K. placers.
20	Eagle	L.G. Smith, Box 652, S. Laguna	2	2N	8W	SB	Head of Coldwater Canyon, $2\frac{1}{2}$ miles west of Old Baldy Peak. Discontinuous, narrow quartz veins in chloritic schist explored by workings now inaccessible. Mill inop-

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
20	Eagle (contd)						erative; no production reported. Idle for years.
	Eagle	J.J. O'Regan et al., 421 Higgins Bldg., Los Angeles (1937)	24	4N	12W	SB	Aliso Canyon, 7 airline miles southeast of Acton. Production undetermined. Long idle. (Sampson 37:194, map.)
	Eagle						See Mount Gleason. (Crawford 96:204; Preston 90a:19; Sampson 37:187; Tucker 27:293.)
	El Centro	Guy Pullen, San Bernardino	Undetermined				Prairie Fork of San Gabriel River, 12 miles west of Cajon. Gold-bearing basic porphyry dike stained with hematite. Developed by 50-ft. tunnel, shallow shafts. Production unknown. Long idle. (Sampson 37:183; Tucker 27:293.)
	Enterprise	Julius Dietzman, 828 S. Figueroa St., Los Angeles (1937)					See Champion. (Sampson 37:194, map.)
	Evening Star						See St. George district. (Preston 90a:199.)
21	Falcon	Falcon Mining Co., John L. Bisher et al., Los Angeles (1942)	1	3N	12W	SB proj.	Central San Gabriel Mts. on west side of Granite Mt. about 10 airline miles southeast of Acton. Most recent activity 1939-1942 when several hundred tons of gold-silver ore were removed. Developed by 4 adits 80-460 ft. long and 180 ft. of shaft and raise. Inactive since 1942.
22	Fox	John F. Vajcek et al., 6113 Wilcox Avenue, Maywood (1949)	20, 29	5N	15W	SB	Coarsegold Canyon, about 7 miles northeast of Saugus. Dry placers carrying undetermined values. Small workings. Long idle.
23	G.C.K. Placers (Dutch Louie)	Leo I. Gordon, 6742½ Kraft Ave., North Hollywood (1951)	9	3N	14W	SB	Pacoima Canyon, 7 airline miles northeast of San Fernando. Placer deposit in stream bed. Worked after bypassing stream through rock promontory via shaft and tunnel. Production unknown. Long idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
24	Gillette (Los Padre)	Undetermined	26	7N	17W	SB proj.	Bear Canyon, Liebre Mt., about 19 miles northwest of Saugus. History undetermined. Reportedly yielded large amount of silver in 1880's. (Smith 51.)
25	Gold Dollar	F.D. Shuck, 206 S. San Jose Dr., Glendora	2	2N	8W	SB	Between Dry Gulch and Coldwater Canyon, 3 miles west of Old Baldy Peak. Quartz veins up to several inches wide invade gently dipping chlorite schist adjacent to a porphyritic diorite intrusive body. Developed by a crosscut adit caved at the portal. Aerial tram brought ore 350 yards to mill, consisting of jaw crusher, ball mill, rake classifier, tables and concentrating bowls, now disassembled. Over 1,000 tons of ore treated 1921-1938, yielding several hundred ounces of gold. Idle for years.
26	Gold Dyke (Tuttle lease)	Rivera Mining Co., c/o Bert Rivera, Star Rt. 1, Box 47, Lancaster (1952). Leased to Big Dyke Mining Co.; W.W. Tuttle, 803 Kodak Dr., Fred Fisher, 627 Occidental, Los Angeles, et al. Operated by J.P. and Lloyd M. Green Fairmont (1937)	26	8N	16W	SB	Neenach district, $1\frac{1}{2}$ miles east of Rogers and Gentry mine. Pegmatite dike 12-30 ft. wide cuts granitic rock and is reported to carry $15 per ton in free gold. Developed by 70-ft. shaft 10 ft. from vein with crosscuts to vein at 15,30, and 40-ft. levels. Mill, now dismantled, included hammer mill, 800 lb. air stamp, amalgamation plates. Small production reported in 1937. Long idle. (See Rivera Mining Co.) (Sampson 37:183.)
	Goldy B						See Lost Canyon. (Sampson 37:192.)
	Gladys	C.C. Huntington, 1123-B 19th St., and K.W. Kremith, 1121-A 19th St., Santa Monica (1950)	11?	5N	14W	SB	Northwest side of Mint Canyon, about 9 miles northwest of Acton, about 3/4 mile northwest of Agua Dulce school. Dolomite, talc, and quartz seams as wide as 8 inches cut limestone and dioritic metamorphic rocks of the Sierra Pelona series. High-grade gold ore found in pockets. Surface stripped and 80 ft. of level workings driven in 1950. Production undetermined. Idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
27	Governor (New York)	Thomas A. and Earl F. Woods, and Mrs. Charles H. McWilliams, 4200 Bandini Blvd., Los Angeles 23 (1953)	23	5N	13W	SB	Three miles north of Acton. (Goodyear 88:332; Merrill 19:476; Preston 90a:192-194; Sampson 37:183-186, 188; 49:63; Simpson 34:407; Storms 93:247; Tucker 27:294-295; 34:318; 38:12; herein.)
	Gray Eagle						See Double Eagle.
28	Heaton	E.V. Strandberg et al., 12912 Beverly Dr., Whittier. Operated by Joe J. McCullah, Box 106, Azusa	19	2N	8W	SB proj.	East Fork of San Gabriel River, about 1 mile north of Camp Bonita. Auriferous river gravels mined discontinuously since early 1900's by drift methods. Two tunnels totaled over 600 ft. of workings, now partially closed. Production undetermined. Intermittently operated by one man.
	Helene	Miss MacLaughlin and Miss Montegrifo, La Crescenta. Leased to J.B. Ewald (1937) (on the property)	20?	5N	12W	SB	About 2 miles east of Acton Junction, about 1/2 mile north of Highway 6. Two parallel quartz veins in granitic rock of Sierra Pelona series reported to carry values up to $3 per ton in gold. Explored by 175-ft. shaft on footwall vein. Production undetermined. Idle since 1937. (Sampson 37:195.)
29	Hi-Grade (Don)	Francis Gage, 1557 S. Fairfax Ave., Los Angeles. Part of property leased to W.M. Reid Rt. 1, Saugus 1953.	27	5N	13W	SB	About 2 airline miles northwest of Acton. (Averill 51:335; Sampson 37:181-183; herein.)
30	Hilltop (Mint Canyon)	Hilltop Mining Co., Inc., J.O. Schoonover, pres., Wm. McNamara, v. pres., H.A. McNamara, sec. (1937)	13	5N	14W	SB	About 1/2 mile south of Mint Canyon highway, 6½ airline miles northwest of Acton. Quartz vein 3-8 ft. wide dips steeply northwestward in fault zone in Sierra Pelona series. Assays reported $6-$25 per ton in gold. Developed by 100-ft. shaft and a 500-ft. crosscut on 100-ft. level. Production undetermined. Idle. (Sampson 37:186.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
31	Holly (Dot)	Albert J. Windon, Box 285, Glendora	19	2N	8W	SB proj.	Placer claim on East Fork of San Gabriel River, about one mile north of Camp Bonita. Worked discontinuously since 1928, yielding a few ounces of gold.
	Josephine	Undetermined	?	3N	12W	SB proj.	North fork of Tujunga Canyon (Mill Creek), about 11 air-line miles southeast of Acton, near Monte Cristo mine. Gold-bearing vein of honeycombed quartz, 3-4 ft. wide, Worked by about 500-ft. of level workings and stopes. Production undetermined. Largely stoped out by 1890; apparently mine and mill idle since then. (Crawford 96:204-205; Preston 90a:197.)
	Kaolin & Manzanita	R.C. Bufkin, 694 N. Los Robles, Pasadena (1937)	16	4N	14W	SB	Soledad Canyon, about 11 miles northeast of San Fernando. Type of operation, production, undetermined. Long idle. (Sampson 37:194, map.)
	Katahdin & Ontario						See Big Horn. (Sampson 37:194, map.)
	Kelly Bros.	T. Kelly, Acton (1896)	31?	4N	12W	SB	Northwest slope of Mt. Gleason about 6 miles south of Acton, adjacent southwest of Mt. Gleason mine. Production undetermined. Long idle. (Crawford 96:204; Merrill 19: 476-477; Preston 90a:195,196.)
32	Lap Wing	Mrs. Tessie Cook Haskins, 268 Burlington Ave., Los Angeles (1951)	28	3N	14W	SB	Limerock Canyon, about $3\frac{1}{2}$ miles north of Sunland. Gold-bearing veins accompany dolomite lenses in granitic metamorphic rocks of San Gabriel complex. Small production reported long ago. Long idle. See Haskins in dolomite section. (Sampson 37:194, 202-203, map.)
	Largo sand and gravel plant	Consolidated Rock Products Co., 2730 S. Alameda St., Los Angeles 58	28,33	1N	10W	SB proj.	San Gabriel Wash, about 1 mile west of Azusa. Fine placer gold recovered as by-product of sand and gravel pit operation.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Last Chance						See Mt. Gleason. (Crawford 94:152; Preston 90a:196.)
33	Little Nugget	Mrs. Ada R. Brown, Rt. 2, Box 27, San Fernando	27	3N	14W	SB	Gold Creek, about 4 miles north of Sunland. Several thousand dollars in gold reported produced from creekbed placer in period 1918-1947. Idle.
34	Lone Cabin	A.J. Campbell, W.M. Simpson, et al., Rt. 1 Box 299, Saugus	6	3N	14W	SB proj.	Sand Canyon, about 7 miles northeast of San Fernando. Several thousand dollars in gold reported produced prior to 1910 from creek gravels. Idle since 1910. (Sampson 37:194, map.)
	Loris	Loris Gold Mining Co., E. Kennedy, pres., Pasadena (1894)	Approx.	2N	12W	SB	Southern slope of San Gabriel Mts., 4 miles north of Pasadena. Undetermined workings in ferruginous metamorphic rock 1-4 ft. wide. Production undetermined. Long idle. (Crawford 94:152.)
35	Lost Canyon (Canyon, Cruzan, Goldy B, Texas Canyon)	Mrs. E.B. Griffith, Box 1033, Newhall. Leased to John and Louie Ruzzamenti, 3431 Keystone Ave., Los Angeles (1953)	14	5N	15W	SB	Texas Canyon at Mystic Canyon, 10 miles northeast of Saugus. Heterogeneous bench gravels, 6-8 ft. thick, bearing fine gold, worked for 1/4 mile. Placer operation limited by lack of water, obtained from dam in Texas Canyon. Production undetermined. Long idle. (Laizure 34:248-249; Sampson 37:179,181,192,194, map; Tucker 27:292,295.)
36	Lovell group	Mary L. Murray and Jean L. Philbin, 6920 Hollywood Blvd., Hollywood	28	3N	14W	SB	West side of Little Tujunga Canyon, about 4 miles northwest of Sunland. Gold-bearing veins in metamorphic rocks of San Gabriel complex developed by adits 40-300 ft. long. No production. Long idle. (Sampson 37:186.)
37	Lovell-North group	Mary L. Murray and Jean L. Philbin, 6920 Hollywood Blvd., Hollywood	21,27, 28	3N	14W	SB	West side of Little Tujunga Canyon, about 4 miles north of Sunland. Gold-bearing veins in granitic metamorphic rocks of San Gabriel complex. Explored by shallow workings. Production undetermined. Long idle. (Sampson 37:186.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
38	Lueck lease	Francis Gage, 1557 S. Fairfax Ave., Los Angeles (1953). Worked by Arthur Lueck, 6836 Hinds Ave., North Hollywood (1949)	27	5N	13W	SB	Two airline miles northwest of Acton, south end of Hi-Grade mine property. Quartz veins 1-1½ ft. wide dip 55° southwest in granodiorite of Sierra Pelona series. Old 30-ft. shaft deepened to 65 ft. in 1949 and 50 ft. of drifting done on 50-ft. level. Ten tons of ore milled at Hi-Grade mine. Three men active in 1949 but idle since then.
	Lummis	Capt. Lummis (1937)	8	3N	11W	SB	North fork of Alder Creek, 7 miles southeast of Acton. Quartz vein 2 ft. wide in granitic rock explored by shallow shafts, short tunnels. Idle since 1927. (Sampson 37:186; Tucker 27:294.)
	Mammoth	S.B. Savage, Acton (1896)	Approx.	5N	13W	SB	About 3 miles northwest of Acton. Details, production, undetermined. Long idle. (Crawford 96:204.)
	Milwaukee						See Big Horn. (Sampson 37:194, map.)
	Mint Canyon						See Hilltop. (Sampson 37:186.)
	Monte Christo						See Monte Cristo.
39	Monte Cristo (Monte Christo, West Vein lease)	Mr. and Mrs. James Walters, Samuel G. Hooper, 4024 Cartwright, North Hollywood (1953)	12,13	3N	12W	SB proj.	Monte Cristo Creek, San Gabriel Mts., 10 miles southeast of Acton. (Crawford 96:204; Merrill 19:477; Phipps 51: Sampson 37:186-187, 195, map; Tucker 27:294; herein.)
40	Mt. Gleason (Eagle, Last Chance)	B.F. Grant, 625 W. 41 Drive, Los Angeles (1937)	31	4N	12W	SB proj.	North slope Mt. Gleason, 6 miles south of Acton. Shattered quartz vein 2½-5 ft. wide, cuts granite and carries sulfide minerals, partly oxidized. Developed by 4 tunnels 200-400 ft. long and an open cut exposing 200-ft. of ore. Samples reported to average $6.80 per ton. Small buildings and ruined milling plant on property. Several thousand dollars reported produced in 1890's. Long idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
40	Mt. Gleason (Eagle, Last Chance) (cont'd)						(Crawford 94:152; 96:204; Merrill 19:476-477; Preston 90a:195, 196; Sampson 37:187-188, 194, map; Tucker 27:293.)
41	Native Son	Native Son Mining Co., Charles Ward, pres., San Bernardino (1937)	23	3N	8W	SB proj.	Ridge north of Prairie Fork of San Gabriel River, 12 miles west of Cajon. Quartz stringers in mica schist and gneiss carry iron sulfides and gold. Developed by 6 tunnels 100-750 ft. long. Several thousand dollars in gold reported produced in early 1900's. Idle since prior to 1927. (Sampson 37:188; Tucker 27:294.)
	New York						See Governor. (Goodyear 88:332; Merrill 19:476; Preston 90a:192-194; Sampson 37:188; 49:63; Simpson 34:407; Storms 93:247; Tucker 27:294-295; 34:318; herein.)
	Newa						See Rogers and Gentry.
	Ore Hill group (Denver Mining and Milling Co.)						See in lead-silver-zinc section. (Sampson 37:188; Tucker 21:318; 27:289-290.)
	Orion	R.C. Bufkin, 694 N. Los Robles, Pasadena (1937)	27	4N	14W	SB	Upper Bear Canyon area, western San Gabriel Mts. about 11 miles northeast of San Fernando. Type of operation, production, undetermined. Long idle. (Sampson 37:195, map.)
	Pacific Beach Mining & Dredging Company	Pacific Beach Mining and Dredging Co., H.F. Parker, sec., Los Angeles (1896)	28?	2S	15W	SB	Pacific Ocean shore sands, Playa del Rey, 4½ miles south of Santa Monica. Black and gray layers of auriferous sand near mouth of Ballona Creek explored by over 100 shafts, 5-20 ft. deep, prior to 1896. Production undetermined. Long idle. (Crawford 96:204.)
42	Padre	E.H. Barmore, 5223½ De Longpre Ave., Hollywood (1937)	31	4N	12W	SB proj.	North slope of Mt. Gleason about 6 miles south of Acton and 1/2 mile northwest of the Mt. Gleason mine. Steeply dipping lenticular quartz vein 1½-3½ ft. wide cuts granitic rock. Developed by 200-ft. adit on vein, a small

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
42	Padre (cont'd)						shaft, and minor crosscuts, partly flooded. Production undetermined. Long inactive. (Crawford 94:152; Goodyear 88:332; Merrill 19:476-477; Preston 90a:195,196; Sampson 37:189.)
	Peabody & West	Peabody & West, Acton (1896)	Undetermined				Mt. Gleason, about 8 miles south of Acton. Production undetermined. Long idle. (Crawford 96:204.)
	Peerless	Undetermined	5?	3N	12W	SB proj.	North slope of Mt. Gleason, about 6 miles south of Acton, about 1/2 mile southeast of Mt. Gleason mine. Production undetermined. Long idle. (Merrill 19:476-477; Preston 90a:195,196.)
43	Pine Spring group	Arthur J. Campbell and Joe Dunkes, Rt. 1 Box 299, Sand Canyon Rd., Saugus (1951)	6	3N	14W	SB proj.	Sand Canyon about 7 miles northeast of San Fernando. Small gold-bearing quartz veins in metamorphic rocks of San Gabriel complex explored by several hundred ft. of level workings. Auriferous creekbed gravels prospected. Idle.
44	Puritan (Union)	R.P. Fenner, T.J. Schaeffer, Mrs. Ira L. Hauser, Acton. Last operated by Puritan Mine Corp., Ltd., Glenn W. De La Mare, 201 N. Myers, Burbank (1940)	21	5N	13W	SB	About 4 miles northwest of Acton and 3/4 mile south of Highway 6. Quartz vein about 4 ft. wide carries free gold and sulfides and dips steeply in deeply weathered gneissic diorite of the Sierra Pelona metamorphic series. Ore shoots are small irregular bunches. Developed by 140-ft. shaft with 60-ft. drift and stope, 65-ft. shaft with short crosscuts. Other workings now inaccessible. Inoperative 5-stamp mill is a relic of very old operation. Large but undetermined production reported prior to 1893. Last operated in 1940 when about 50 tons of ore were milled at the Governor mill. Idle since 1940 and machinery removed. (Crawford 94:153; Sampson 37:189; Storms 93:247; Tucker 27:295.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Puritan Extension	Lewis S. Winterburn, 25 S. Mentor Ave., Los Angeles (1937)	21	5N	13W	SB	Four miles northwest of Acton, surrounding Puritan mine property. Three-ft. quartz vein in sheared gneissic diorite explored by 70-ft. shaft and 20-ft. crosscut. Idle since 1937. (Sampson 37:189.)
45	Ragan and Williams lease	W.J. Rogers and Thomas Gentry, Fairmont (1937)	26,27	8N	16W	SB	Neenach district, east side of Adams Canyon, just south of Brite lease, on Rogers and Gentry property. Extension of Brite vein sought by 250-ft. tunnel which stopped about 300 ft. short of vein. No production. Idle since before 1937. (Sampson 37:189.)
	Reberg	George Reberg (1894)					See St. George district. (Crawford 94:152.)
46	Red Rover	Governor Mine Co. (1931-1940); Thomas A. and Earl F. Woods, and Mrs. Charles H. McWilliams (1953), 4200 Bandini Blvd., Los Angeles 23	22,23	5N	13W	SB	About 4 miles north of Acton. (Crawford 94:153; 96:204; Goodyear 88:332-333; Merrill 19:476; Preston 90a:191-192; Sampson 37:189-190; Simpson 34:407; Storms 93:246; Tucker 27:295; herein.)
47	Rivera Mining Co. (includes Gold Dyke, Tuttle lease)	Bert Rivera, Star Rt.1, Box 47, Lancaster (1952)	26	8N	16W	SB	Neenach district, about 4 miles southeast of Neenach school. Prospected since 1934 by short adits and shallow shafts resulting in no production, except Gold Dyke lease, which see. Idle since 1949. (Sampson 37:183,190,193; Weise 50:47.)
	Robinette	Smith Bros. Leased to Earl Robinette et al., Torrance (1937).	12?	4N	16W	SB	Junction of Haskell and Bouquet Canyons, about 2½ miles northeast of Saugus. Unsorted river deposit of clay, gravel, and boulders reportedly bearing some gold. Production undetermined. Idle since prior to 1937. (Sampson 37:191.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
48	Rogers and Gentry (Newa, Big Susanna vein)	Leo and Esther Harris, 4542 Lomita St., Los Angeles. Leased to Livingstone Greenwood, pres., Newa Mining Corp 3433 W. 64th St., Seattle, Washington. (Star Rt. 1, Box 49A, Lancaster (1952))	27	8N	16W	SB	Neenach district, about 4 miles southeast of Neenach school. See also Brite lease. (Sampson 37:191; Tucker 34:318-319; 38:12; herein.)
49	Rose Hill	J.W. Ferree, John Sisson, et al.	29	5N	15W	SB	Coarsegold Canyon, about 7 miles northeast of Saugus. Dry placers carrying undetermined values. Small workings. Long idle.
	Russell and Myler lease	W. Scott Russell, Lancaster, and E.J. Myler, Rosamond (1937)					See Ventura-Neenach. (Sampson 37:191; Wiese 50:47.)
	St. George district (Evening Star, Reberg, Star of the East, Star of the West)	Undetermined	35,36	4N	15W	SB	Sand Canyon area, about 8 airline miles east of Saugus. Quartz vein averaging 20 inches wide in metamorphic rocks of San Gabriel complex. As much as $25 per ton in gold reported. Explored by small underground workings. Production undetermined. Long idle. (Preston 90a:199.)
	San Gabriel Canyon area placers						San Gabriel River and San Antonio Canyons, north and northeast of Glendora. River bottom and terrace gravel deposits hydraulicked mostly prior to 1900. Activities concentrated in Cattle, Coldwater, East Fork of San Gabriel River, and San Antonio Canyons. (Goodyear 88:340; Merrill 19:473,475; Peck 38:5-14; Preston 90a:209; Sampson 37:177; Storms 93:248; Tucker 27:291; herein.)
50	San Gabriel Valley placers	Robert A. Riggs, 1237 S. Greenwood Ave., Montebello	3	1S	10W	SB	Azusa Rock and Sand Co. plant, south of Azusa. (Averill 50:335; herein.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Santa Paula	G. Cruger, Acton (1894)	34?	5N	13W	SB	About $1\frac{1}{2}$ miles west of Acton. Small vein intermittently worked in past. Production undetermined. Long idle. (Crawford 94:153.)
	Savage	Mr. Savage, Monrovia (1894)	Approx.	5N	13W	SB	About 5 miles west of Acton. Ferruginous quartz interstratified with talc rock in veins 10-50 ft. wide in zone 120 ft. or more wide. Explored by crosscut adit. Assays, production, undetermined. Long idle. (Crawford 94:153.)
51	Scorella	G.V. Scorella, Los Angeles (1937). Leased to G.S. Hancock, 3339 West 8th St., Los Angeles (prior to 1937)	1	4S	16W	SB	Haskell Canyon, about $4\frac{1}{2}$ miles northeast of Saugus. Reconcentrated terrace gravel 4-6 ft. deep in gulches carries 80 cents per yard in gold. Explored by short tunnels and treated in Ainley bowl. Production undetermined. Idle since 1937. (Sampson 37:191,195, map.)
	Silver King						See in lead-silver-zinc section.
	Silver Mountain	Colonel De Freese and Barrett (1890)	Undetermined				Upper Castaic Creek area, about 10 (?) miles north of Castaic. Sulfide ore containing galena and pyrite explored by minor underground workings. Reported test values of $8.22 per ton. Production undetermined. Long idle. (Preston 90a: 203-204.)
52	Skipper	Roy W. Spurrier, 17441 Huntington Beach Blvd. Huntington Beach (1951)	29	5N	15W	SB	Coarsegold Canyon, about 7 miles northeast of Saugus. Dry placers, minor workings. Production undetermined; long idle.
	Smith Bros.	J.A. and D.N. Smith. Leased to King C. Gillette, Los Angeles, in 1933	12?	4N	16W	SB	Haskell Canyon junction with Bouquet Canyon, about 6 miles northeast of Saugus. Unsorted creekbed gravels explored by 50-ft. shaft with 140-ft. drift on 50-ft. level. As much as 75 cents a yard in gold reported. Operation included railroad haulage and spiral concentrator washing plant. Production undetermined. Idle since prior to 1937. (Sampson 37:191-192.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
53	Soledad Placer Co., (Conroy Ranch)	Soledad Placer Co., W.J. Clark et al., Los Angeles Police Department (1937)	11,12	4N	16W	SB proj.	Bouquet and Dry Canyons, about 3 miles east of Saugus. Eroded bench gravels worked intermittently by dry placer methods for many years prior to Soledad Placer Co. operation in 1935. Company handled 40 yards per hour with 2-yard drag line, trommel screens, and Ainley bowls. About 250,000 yards of material treated. Production undetermined. Idle since 1935. (Sampson 37:192.)
54	Spanish	Joseph Connley, Los Angeles, Earl Yetz, Bakersfield, and Frank Wesley, Newhall (1948)	28	5N	14W	SB	About 9 miles west of Acton. Quartz veins in metamorphic rocks of Sierra Pelona series explored by extensive, although undetermined, underground workings. Production undetermined. Road built in 1948 but idle since then.
55	Stanley (Chuckawala, Stanley Miller)	B.E. Ford, 2081 Marlborough, Riverside. Leased to Chuckawala Mining Co., Marvin R. Thompson, 344½ W. 11th St., Azusa, and H.M. Bowden, 520 E. Carson, Torrance	5	2N	8W	SB	East Fork of San Gabriel River about 5 airline miles northeast of Camp Bonita. Discontinuous quartz veins up to 2 ft. wide, lie along schistosity of knotty chlorite schist, dip gently eastward. Vein system explored for 350 ft. underground by irregular level workings. Several hundred tons of ore treated in 1933-38 yielding several thousand dollars in gold. Mill consisting of jaw crusher, ball mill, rake classifier, and several tables, inoperative and property idle when visited in 1952.
	Stanley Miller						See Stanley.
	Star of the East						See St. George district. (Preston 90a:199.)
	Star of the West						See St. George district. (Preston 90a:199.)
	Sunshine	Christman, Fuller, and Meuer (1922)	Undetermined				Bouquet Canyon, about 10 miles from Saugus. Quartz vein 25 ft. wide reported to assay as much as $10.30 in gold, 3 ounces of silver per ton. Quartz vein 20 ft. wide explored to 50-ft. depth in 1922, but production undetermined. Idle for years. (Newman 23a:422; Sampson 37:198-199; Tucker 27:317.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Tajungo						See Tujunga.
	Texas Canyon						See Lost Canyon. (Laizure 34:248-249; Sampson 37:192; Tucker 27:295.)
56	Toney	Anthony O. Truschel, 2367 W. 20th, Los Angeles	28	5N	14W	SB	About 8 miles west of Acton. Gold-bearing vein in metamorphic rocks of the Sierra Pelona series explored by 50-ft. shaft and undetermined level workings. Production undetermined. Long idle.
	Topeka	E.B. Millar, 141 Broadway, Los Angeles (1894)	Approx.	5N	13W	SB	About 3 miles west of Acton, vicinity of Governor mine. Reported to have been large producer prior to 1893. Details undetermined. Long idle. (Crawford 94:153; Storms 93:247.)
	Triumph	W.L. Hastings, Acton (1896)	Approx.	5N	13W	SB	About 6 miles northwest of Acton. Developed by 240-ft. adit, 25-ft. shaft. Values, production undetermined. Long idle. (Crawford 96:205.)
	Tuch & Dether	J.O. Frazer. Leased to Robert Allen, subleased to Tuch & Dether, Los Angeles (1937)	14	5N	16W	SB	South side San Francisquito Canyon, about 8 miles northeast of Saugus. About 500 yards of gravel from bench 5 ft. thick hydraulicked with well water. Production undetermined. Long idle. (Sampson 37:192-193.)
	Tujunga (Tajungo) group	Undetermined	?	3N	12W	SB proj.	North fork of Tujunga Canyon (Mill Creek), about 11 airline miles southeast of Acton, near Monte Cristo mine. Decomposed quartz vein 1-2 ft. wide in granitic rock of San Gabriel metamorphic complex. Explored on several claims by inclined shafts, drifts, and stopes totalling about 1,000 ft. of workings. Production undetermined. Long idle. (Crawford 96:204-205; Preston 90a:197-198.)
	Tuttle lease						See Gold Dyke. (Sampson 37:193.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Union						See Puritan. (Crawford 94:153; Sampson 37:193; Storms 93: 247; Tucker 27:295.)
	Utopia						See Champion.
57	Ventura-Neenach Mining Co. (Russell & Myler; includes Brite lease)	W.J. Rogers and Thomas Gentry, Fairmont (1937) Leased to C.E. Apling & Dr. Mosher, Ventura, and Sol E. Camp (1937)	26,27	8N	16W	SB	Neenach district, about 3 airline miles southeast of Neenach school. A 200-ft. inclined shaft follows quartz vein dipping 45° in coarse, weathered diorite, talcose where altered. Connects with Brite vein at 100-ft. level where ore averaged $40 per ton and was stoped for 125 ft. average width 3 ft. About 200 ft. of other underground workings include a 72-ft. crosscut at the 200-ft. level. Production reported to exceed $50,000 from the entire property, including Brite lease. Long idle. (Sampson 37: 179,191,193; Wiese 50:47.)
	Victoria						See in lead-silver-zinc section.
58	Walker Ranch placers	Frank E. Walker, Box 277, Newhall	3	4N	15W	SB	Placerita Canyon at Los Pinetos Canyon, about 7 miles southeast of Saugus. Auriferous creek gravels worked at intervals since early 1800's. Tested and reworked on small scale 1946-1949. Production undetermined. Idle.
	West Vein lease						See Monte Cristo. (Sampson 37:187.)
	Whitter	C.L. Wilson, Acton (1896)	Approx.	5N	13W	SB	About 3 miles northwest of Acton. Status undetermined. Long idle. (Crawford 96:205.)
59	Zanteson	R.A. Zanteson and Charles Crail, 258 S. Vendome St., Los Angeles (since 1951)	30	2N	8W	SB proj.	Cattle Canyon, east of East San Gabriel Canyon, about 1/2 mile east of Camp Bonita Ranger Station. Coarse placer gold in unsorted alluvium 125 ft. above stream, site of former hydraulic mining. Bedrock exposed in 30-ft. face by hand methods; ore chuted to 18-ft. sluice box at stream level. Test production only. Two men working intermittently.

LEAD, SILVER, ZINC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
60	Black Jack	Santa Catalina Island Co., Avalon	24 (?)	9S	14W	SB proj.	Santa Catalina Island, northeast slope of Black Jack Mt., 14 miles northwest of Avalon. (Preston 90b:279; Sampson 37:198; Tucker 27:33-34, 314-315; herein.)
	Denver - Indicator						See Ore Hill. (Sampson 37:198; Tucker 27:315.)
	Denver Mining & Milling Co.						See Ore Hill. (Sampson 37:176; Tucker 21:318; 27:288,289-290.)
	Emma						See Emma in copper section. (Merrill 19:479.)
	Great West	Undetermined	Undetermined				Upper Castaic Creek area, about 10 (?) miles north of Castaic. Quartz vein near limestone belt in granitic rock reported to carry $28 per ton in silver. Explored by prospect cuts and short tunnels. Production undetermined. Long idle. (Preston 90a:204.)
	Kelsea						See Kelsey (Crawford 96:204.)
61	Kelsey (Kelsea, Mint, South Extension OK)	W.L. Ohmer, 8602 Chapman, Garden Grove and L.W. Roper, 611 N. Lemon, Anaheim (1952)	12	1N	10W	SB	Water Canyon, one mile east of Morris Reservoir in San Gabriel Canyon, 3 miles north of Glendora. Four-ft. wide vein bearing lead, silver, and gold occupies fault zone in schist and hornblende gneiss of San Gabriel metamorphic complex. Developed by 2 adits, 150-and 200-ft. long, caved by 1927. Small-scale operation prior to 1910 and in 1934 but idle since. (Crawford 96:204; Merrill 19:478, 479; Newman 23:422; Preston 90a:208; Sampson 37:194,198, map; Storms 93:243-245; Tucker 27:315-316.)
	Lost Treaure	Holcomb, Barber, and Fairs, Azusa (1922)	Undetermined				San Gabriel Canyon, about 6 miles northeast of Azusa. Streak 6 inches wide reported to assay as much as 50 ounces of silver per ton. Explored by open cut and adit 50 ft. below cut. Activity, production undetermined; long idle. (Newman 23a:422; Sampson 37:198; Tucker 27:316.)

LEAD, SILVER, ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mint						See Kelsey (Preston 90a:208.)
62	Ore Hill group (Denver, Denver-Indicator)	Leo I. Gordon, 6742½ Kraft Ave., North Hollywood (1952). Denver Mining and Milling Co., (prior to World War I)	10,11	3N	14W	SB	Pacoima Canyon, about 8 airline miles northeast of San Fernando. Lead, zinc, copper, and silver sulfides in 2-4 ft. wide quartz veins in granite gneiss. Reports of nickel, cobalt, and antimony. Explored by shallow workings, 25-ft. shaft being sunk in 1952. No production. (Sampson 37:176, 188,198; Tucker 21:318; 27:288,289-290, 315.)
63	Quarry	Santa Catalina Island Co., Avalon	2(?)	10S	14W	SB proj.	Santa Catalina Island, rock quarry 1½ miles southeast of Avalon. (Sampson 37:198; Tucker 27:36-37, 316; herein.)
64	Renton Vein	Santa Catalina Island Co., Avalon	11(?)	10S	14W	SB proj.	Santa Catalina Island, Renton Canyon, 2 miles southeast of Avalon. (Sampson 37:198; Tucker 27:34-36, 316; herein.)
	Sierra Madre Silver Mining Co.						See Victoria. (Crawford 96:204; Merrill 19:479; Sampson 37:199.)
	Silver King	Clarence A. Cruzan, R.F.D. 72 K, Oceanside, and William E. Cruzan, 12622 S. Main St., Los Angeles	18	5N	14W	SB	Texas Canyon about 12 miles northeast of Saugus. Quartz vein 2 ft. wide strikes east, dips moderately north in sheared zone parallel to bedding plane in pebble conglomerate and sandstone of Vasquez series. Ore contains galena, iron and manganese oxide stains, and is reported by owner to carry 10-30 ounces in silver per ton. Developed by glory hole and two tunnels, 100 and 250 ft. long, and shallow workings. Production undetermined; idle. (Sampson 37:198; Tucker 27:317.)
	South Extension OK						See Kelsey (Sampson 37:map.)
	Sunshine						See under gold.
	Victoria	Sierra Madre Silver Mining Co., Azusa	12,13 (?)	1N	10W	SB Approx.	SanGabriel Canyon, 6 miles northeast of Azusa, across canyon from Kelsey mine. Active about 1890 with produc-

LEAD, SILVER, ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Victoria (continued)	(prior to 1937)					tion undetermined. Idle since before 1893. (Crawford 96:205; Newman 23a:422; Preston 90a:208; Sampson 37:199; Storms 93:246; Tucker 27:317.)

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Amargosa group (Black Brothers, Llewellyn Iron, Mayet, Red Feather, La Frentz)		30 24	6N 6N	12W 13W	SB SB	East end of Portal (Ritter) Ridge, about 5 miles west of Palmdale. Amargosa group dates from World War I. Includes two principal groups of claims about 2 miles apart, the Red Feather (La Frentz) workings to the west, and the Black Brothers (Llewellyn Iron) claims to the east, which see. (Bradley 18:38;Merrill 19:478; Sampson 37:199; Trask 43:60,79,129, map; 50:100-103; Tucker 21:320; 27:317-318.)
65	Black Brothers (Amargosa, Llewellyn Iron)	Llewellyn Iron Co., Los Angeles (1917). Operated (1943) by Black Brothers (?)	30	6N	12W	SB	Ritter Ridge, 4.3 miles west of Palmdale. Manganiferous quartzite bed averages 3 ft. wide, traceable 165 ft. through pre-Cambrian (?) quartz-mica schist. Rhodonite and spessartite among quartz grains of schist, partly oxidized to psilomelane and soft black oxides. Little good oxide ore found. Developed during World War I (?) by adit and shaft, now caved. Bulldozed 1941 or 1942. Average grade 20% Mn, much silica. Production undetermined. Idle. (Bradley 18:38; Trask 43:129, map; 50:100-101.)
	Gladwin and Peet	G.L. Gladwin and H.G. Peet, Los Angeles (1917)	36	6N	13W	SB	Near Anaverde Valley, about 6 miles west of Palmdale. Showings of manganese oxides in small pockets along silicious outcrops in schist. Minor prospecting only. Long idle. (Bradley 18:38; Trask 43:129, map; 50:101.)
	La Frentz						See Red Feather and Amargosa group. (Trask 43:79; 50:102-103.)
	Llewellyn Iron						See Black Brothers and Amargosa group. (Trask 43:129; 50:100-101.)
	Mayet						See Amargosa group. (Merrill 19:478.)
	Purple Sage group	Clarence A. Cruzan, R.F.D. 72-K Oceanside.	5,7	5N	14W	SB	Texas Canyon, south flank of Sierra Pelona, 15 miles northeast of Saugus. Manganiferous quartzite, 9-10 ft.

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Purple Sage group (contd)	Leased to John and Louie Ruzzamenti, 1051 Stilson St., Los Angeles (1953)					thick, reportedly several hundred ft. in exposed length, enclosed in pre-Cambrian (?) schist. Rhodonite, partially oxidized to pyrolusite and psilomelane, in pockets and lenses up to 2 ft. thick. Assays as much as 30-40% manganese but estimated to average less than 10%. Prospected in shallow surface workings. No production. Idle for years. (Trask 43:60,129, map; 50:101-102.)
66	Red Feather (Amargosa group, La Frentz)	H.E. and M.M. La Frentz, Palmdale (1942). Leased to G.T. Humphreys, Los Angeles (prior to 1950)	24	6N	13W	SB	Crest of Portal Ridge, about 6 miles west of Palmdale. Rhodonite partly oxidized to psilomelane and soft black oxides in lenses of quartzite enclosed in pre-Cambrian (?) quartz-mica schist. Discontinuous lenses 1-6 ft. wide, with pockets and disseminated grains of rhodonite. Developed and mined by shallow workings scattered over total length of 750 ft. Production of 168 tons during World War I credited to Red Feather claim. Long idle. (Trask 43:60,79,129, map; 50:102-103.)

MOLYBDENUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Manzanita	Undetermined		2N	12W	SB	Lang Canyon, 6 miles north of Altadena. Molybdenite associated with copper in a quartz vein in granite. Development, production, undetermined. Idle since prior to 1927. (Murdoch 50:214; Sampson 37:200; Tucker 27:318.)
	Winter Creek group						See in copper section. (Murdoch 50:214.)

TITANIUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
66	Acton 1 deposit	Undetermined	30	4N	12W	SB proj.	West side of Arrastre Canyon, about $4\frac{1}{4}$ airline miles south of Acton. Many small occurrences of titaniferous magnetite with quartz, microcline, and hornblende in gabbroic anorthosite. Estimated reserve; 2,000 tons carrying 5-10% TiO_2. No production. Idle. (Oakeshott 48:257; plate 25.)
67	Alder Creek 2 deposit	Undetermined	13,24	3N	12W	SB proj.	West ridge of Iron Mt., about $10\frac{1}{2}$ airline miles southeast of Acton. Many small outcrops of titaniferous magnetite in anorthosite. No production. Idle. (Oakeshott 48:259, plate 25.)
68	Alder Creek 4 deposit	Undetermined	23	3N	12W	SB proj.	Southwest ridge of Iron Mt., about 11 airline miles southeast of Acton. Small amounts of titaniferous magnetite in chlorite schist. No production. Idle. (Oakeshott 48:259, plate 25.)
69	Alder Creek 5 deposit	Undetermined	25	3N	12W	SB proj.	North side of Big Tujunga Creek, west of Lynx Gulch, about 12 airline miles southeast of Acton. Hundreds of small irregular masses of chlorite schist and pyroxenite bearing titaniferous magnetite, within anorthosite and gabbro. Estimated reserve; 2,000,000 tons carrying 3-20% TiO_2. No production. Idle. (Oakeshott 48:259-261, plate 25.)
70	Asphalt Products Co.	Asphalt Products Co., 112 W. Jefferson Blvd., Los Angeles (1947)	17	4N	14W	SB	Mouth of Pole Canyon, about 1/4 mile southeast of Lang. Pilot plant operated in 1947 to recover titaniferous magnetite granules in Pole Canyon alluvial fill for use in roofing paper. No production. Idle since 1947.
	Beam Smelter Co. and associates	F.C. Groff, Harold Kinney, Arthur Mallory, Bob and Jack Merical, and Walter Rechsteiner		3,4N	12, 13W	SB	West side of Mill Creek southeast of Iron Mt. and Mt. Gleason, about 9 airline miles southeast of Acton. (Herein.)

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Beam Smelter Co. and associates (continued)	in association with L.M. Beam, 10535 Buford Ave., Inglewood					
71	Black Crow	W.R. Braden, 1114-C N. Central Ave., Glendale (1952)	14	3N	12W	SB proj.	Monte Cristo Canyon, about 10 miles southeast of Acton. Body of titaniferous magnetite about 100 ft. long, 25 ft. wide in chlorite schist with coarse hornblende gabbro; anorthosite surrounds deposit. Prospect pit about 10 ft. by 10 ft. by 10 ft. No production. Idle in 1952.
72	Bryant	R. Bryant (1927)	15	3N	13W	SB proj.	South slope of Iron Mt. near head of Trail Canyon, about 9 airline miles south of Acton. Altered pyroxenite with many irregular masses of titaniferous magnetite. Estimated reserve: several million tons carrying 2-3% TiO_2, a few thousand tons carrying 5-15% TiO_2. No production. Idle. (Miller 34; Oakeshott 48:258, plate 25 ("Trail Canyon 5"); Sampson 37:197; Tucker 27:297.)
73	Burdick	Burdick Minerals Corp., F.F. Burdick, pres., 330 Second St., Hermosa Beach (1927)	7,18, 19	4S	14W	SB proj.	Pacific Ocean beach, between Redondo Beach and Palos Verdes. Lenticular concentration of black sand, 8 in.-14 ft. thick, believed to contain 20% titaniferous magnetite. Sand was wet-screened to minus 30-mesh size at mining site and trucked to stockpile at plant in Hermosa Beach. Separation of ilmenite and magnetite attempted using table and magnetic concentrator;14 men employed. Production undetermined. Inactive since 1927. See Johnstone and Wright. (Sampson 37:197; Tucker 27:298-299.)
74	Condor	Will Baughman, 141 W. Ave., 30, Los Angeles 31 (1952)	9	3N	12W	SB proj.	Peak between North and Middle Forks of Mill Creek, about 9 airline miles southeast of Acton. Lenticular mass of titaniferous magnetite traceable for 600 ft. in anorthosite. Exposure 50 ft. long, 20 ft. wide reported to carry 15% ilmenite, 40% magnetite. Estimated reserve: 180,000 tons carrying 5-10% TiO_2. No production. Idle. (Baughman:

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
74	Condor (continued)						personal communication 1952; Miller 34; Oakeshott 48:259, pl. 25 ("Mt. Gleason 4"); Sampson 37:196; Tucker 27:297.)
	Daytonia						See Daytonian. (Tucker 27:297.)
75	Daytonian (Daytonia)	Stanley H. Collins, c/o Will Baughman, 141 W. Ave. 30, Los Angeles 31	14	3N	12W	SB proj.	North side of Monte Cristo Creek, about 10 air miles southeast of Acton. Titaniferous magnetite outcrops 3-8 ft. wide, about 25 ft. long. No production. Long idle. (Baughman: personal communication 1952; Sampson 37:196; Tucker 27:296-297.)
	Du Pont	Pigment Div. of E.I. du Pont de Nemours & Co., Wilmington 98, Delaware		3,4N	12, 13, 14W	SB	Vicinity of Sand Canyon, upper Pacoima Canyon, and Mill Creek, between Live Oak and Monte Cristo mines. Many claims marked, trenched, sampled, and surveyed with magnetometer in period 1927-1938. No production, all claims abandoned. (Oakeshott 48:250, pl. 25 ("Alder Creek 1", "Alder Creek 5", "Mt. Gleason 7"); Sampson 37:196.)
76	Ferro-Titan (Minerals Research Co.)	Ferro-Titan Minerals Co., N.C. Amen and F. M. Moody, 212 Bank of America Bldg., Glendale. Roscoe plant of Consolidated Rock Products Co., Box 2950, Terminal Annex, Los Angeles	19,30	2N	14W	SB proj.	San Fernando Valley, about 4½ miles southeast of San Fernando. Heavy sands removed from sand-gravel operation by black-sand pans and magnetic separator. Concentrated to 92% combined ilmenite-magnetite in 45:55 ratio. About 2,000 tons produced 1947-1951, mostly minus 30 mesh, and used for granules in tarred-roll roofing. Inactive. (Hazenbush 51:335; Moody, F.M.: personal communication 1953.)
77	Iron Blossom (Titian)	Oliver Andreason and W.B. Allison, Los Angeles (1927). Operated by Mineral Increment Co., R.C. McInerny,	21,28	4N	14W	SB	Ridge between Bear and Pole Canyons, about 2½ miles southeast of Lang. Small irregular masses of titaniferous magnetite 6-8 ft. wide, 30-50 ft. long in gabbro-diorite. In 1927-1928 several adits, one over 300 ft. long, were driven and about 10,000 tons of ore mined for use in

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
77	Iron Blossom (Titian) continued	pres., Richmond (1927-1928).					paint base. Estimated reserve: 200,000 tons carrying 18-20% TiO_2. Idle since 1928. (Miller 34; Oakeshott 37:248; 48:249-250, 257, pl. 25 ("Lang 3"); Sampson 37:197; Tucker 27:297, 298.)
	Iron Mack	H. Reblick, Acton and E.L. Baker, 713 W. First St., Los Angeles (1906)	36	6N	14W	SB	Head of Mint Canyon, about 10 miles north of Acton. Deposit of low-grade material containing small pockets of magnetite and manganese minerals. Production reported from pit less than 10 ft. deep prior to 1906; idle since. (Aubury 06:298; Boalich 23:111; Merrill 19:478; Sampson 37:197; Tucker 27:297.)
78	Iron Mountain	Will Baughman, 141 W. Ave. 30, Los Angeles 31	13,24	3N	12W	SB proj.	Southeast of Monte Cristo Creek, near peak of Iron Mt., about 11 airline miles southeast of Acton. Many small lenses of ilmenite-magnetite in gabbroic anorthosite along north-trending ridge. No development. Idle. (Baughman: personal communication 1952; Oakeshott 48:259, pl. 25 ("Alder Creek 3"); Sampson 37:196; Tucker 27:297.)
	Johnstone and Wright	Walter Johnstone and Thomas J. Wright, 100 E. Colorado Blvd., Pasadena. Plant at 330 2nd St., at Santa Fe RR tracks, Hermosa Beach					Hermosa Beach. Former Burdick Minerals Corp. plant now producing granules for roofing paper. See Burdick. (Tucker 27:298-299; herein.)
79	Lang 2 deposit	Undetermined	11	4N	14W	SB	Soledad Canyon, 2000 ft. west of Russ siding on S.P.R.R. Traces of titaniferous magnetite with diorite-gabbro in anorthosite. No production. Idle. (Oakeshott 48:256, pl. 25.)
80	Lang 4 deposit	Undetermined	16	4N	14W	SB	Soledad Canyon, mouth of Bear Canyon, about 1.7 airline miles east of Lang. Titaniferous magnetite in anorthosite

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
80	Lang 4 deposit (cont'd)						at gabbro-anorthosite contact. No production. Idle. (Miller 34; Oakeshott 48:257, pl. 25.)
81	Little Tujunga 4 deposit	Undetermined	4,9	3N	14W	SB	Ridge between Sand and Pacoima Canyons, about 11½ airline miles southwest of Acton. Titaniferous magnetite in irregular masses of altered pyroxenite in gabbro-diorite Estimated reserve: 70,000 tons carrying 5-8% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
82	Little Tujunga 5 deposit	Undetermined	4	3N	14W	SB proj.	Upper Sand Canyon, about 11 airline miles southwest of Acton. Titaniferous magnetite in altered pyroxenite within basic gabbro. Estimated reserve: 80,000 tons carrying 5-8% TiO_2 and several hundred thousand tons carrying 3-5% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
83	Little Tujunga 6 deposit	Undetermined	35	4N	14W	SB	East ridge of Magic (Iron) Mt., about 9 airline miles southwest of Acton. Scattered small outcrops of titaniferous magnetite in anorthosite. Estimated reserve: 50,000 tons carrying 5% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
84	Little Tujunga 7 deposit	Undetermined	11	3N	14W	SB	North side of Pacoima Canyon, about 10½ airline miles southwest of Acton. Titaniferous magnetite in lenticular mass of pyroxenite within gabbro. Estimated reserve: 750,000 tons carrying 5-6% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
85	Little Tujunga 8 deposit (Trail Canyon 1 deposit)	Undetermined	12	3N	14W	SB	South side of Pacoima Canyon, about 9½ airline miles southwest of Acton. Titaniferous magnetite in pyroxenite associated with quartz masses. Estimated reserve: 800,000 tons carrying 5-6% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
86	Little Tujunga 9 deposit	Undetermined	2	3N	14W	SB proj.	North side Pacoima Canyon, about 9½ airline miles southwest of Acton. Small amounts of titaniferous magnetite in scattered bodies of pyroxenite. Estimated reserve: 10,000 tons carrying 4-5% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
87	Little Tujunga 10 deposit	Undetermined	3	3N	14W	SB proj.	Dagger Flat Canyon, south of Magic Mt., about 10½ airline miles southwest of Acton. Small amounts of titaniferous magnetite in scattered bodies of pyroxenite. Estimated reserve: 5,000 tons carrying 4-5% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25.)
88	Little Tujunga 11 deposit	Undetermined	9	3N	14W	SB	Pacoima Canyon, about 12 airline miles southwest of Acton. Placer deposit of black sand extends 4,000 ft. west of Dagger Flat, commonly more than 40 ft. deep. Samples contain 2.4-30.8% TiO_2. Estimated reserve: several million tons of workable sand. No production. Idle. (Oakeshott 48:257,261,265, pl. 25.)
89	Live Oak	Live Oak Mines, Inc., Challoner Thompson, pres., Sand Canyon, Rt. 1, Box 298-A, Saugus (1952)	1 36 31 6	3N 4N 4N 3N	15W 15W 14W 14W	SB SB SB SB	Sand Canyon, about 9 airline miles east of Saugus. Creek-bed placer concentration of titaniferous magnetite explored to 40-ft. depth. Electromagnetic separation of ilmenite and magnetite attempted intermittently 1944-1949. Product used in roofing granules, pigment, heavy aggregate. Production undetermined. Estimated reserve: 200,000 tons carrying 8% TiO_2 in place; several million tons of placer sand averaging 7.5% TiO_2. Idle. (Oakeshott 48:250, 257, 261, pl. 25)("Little Tujunga 1").
90	Lodestone	Will Baughman, 141 W. Ave. 30, Los Angeles 31 (1952)	11	3N	12W	SB proj.	Mill Creek Canyon, about 9½ airline miles southeast of Acton. Body of titaniferous magnetite up to 100 ft. long and 5-10 ft. wide in pyroxenite within anorthosite. Reported 7-18% ilmenite. Undeveloped. Idle. (Baughman:personal communication 1952; Oakeshott 48:259, pl. 25 ("Mt. Gleason 5"); Sampson 37:196, 213, map; Tucker 27:297.)

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
91	Mason & Allen	Sam Mason and A.E. Allen, 3818 Tweedy Blvd., Southgate (1951)	4,5, 8,9	3N	14W	SB proj.	Sand Canyon, about $11\frac{1}{2}$ airline miles southwest of Acton. Small irregular masses of titaniferous magnetite with altered pyroxenite in gabbro-diorite. Estimated reserve: 100,000 tons carrying 5-10% TiO_2. No production. Idle. (Oakeshott 48:257, pl. 25 ("Little Tujunga 3").
92	Mount Gleason 1 deposit	Undetermined	12	3N	13W	SB proj.	South side of head of Pacoima Canyon, about $7\frac{1}{2}$ airline miles south of Acton. Small outcrops of titaniferous magnetite in gabbro. Estimated reserve: 10,000 tons carrying 5-10% TiO_2. No production. Idle. (Miller 34; Oakeshott 48:259, pl. 25.)
93	Mount Gleason 2 deposit	Undetermined	31	4N	12W	SB proj.	Northwest ridge of Mt. Gleason, about 6 airline miles south of Acton. Titaniferous magnetite in gabbro. Estimated reserve: few thousand tons carrying 5-10% TiO_2. No production. Idle. (Miller 34; Oakeshott 48:259, pl. 25.)
94	Mount Gleason 3 deposit	Undetermined	4,9	3N	12W	SB	Between heads of Middle and North Forks of Mill Creek, about $7\frac{1}{2}$ airline miles southeast of Acton. Many small irregular outcrops of titaniferous magnetite in zone a few ft. wide. No production. Idle. (Oakeshott 48:259, pl. 25.)
95	Mammoth	F.F. Burdick, 330 Second St., Hermosa Beach (1927)	23	3N	12W	SB proj.	East side of Mill Creek, about 11 airline miles southeast of Acton. Several small masses of titaniferous magnetite in anorthosite. No production. Idle. (Oakeshott 48:259, pl. 25 ("Mt. Gleason 6"); Tucker 27:297.)
96	Needham and Boruff	Fred Boruff and H.C. Needham, Newhall (1927)	31	4N	14W	SB proj.	Iron Canyon, about 12 airline miles southwest of Lang. Showings of titaniferous magnetite with pyroxenite dikes in gabbro. Undeveloped. Idle. (Oakeshott 48:257, pl. 25 ("Little Tujunga 2"); Sampson 37:197; Tucker 27:298.)

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
97	Russ Siding	John Carroll, 4th & Juniper Sts., Long Beach, and J.D. Rivard 2915 Downey Ave., Los Angeles (1906)	11	4N	14W	SB	North side Soledad Canyon, opposite Russ Siding, about 7 airline miles west of Acton. Small irregular mass of ilmenite-magnetite in fractured anorthosite. Small production from short tunnel prior to 1906 unsuccessfully treated in oil burning furnace at deposit. Estimated reserve: 100 tons carrying 18-20% TiO_2. Idle since prior to 1906. (Aubury 06:297; Boalich 23:110; Merrill 19:478; Oakeshott 48:249,256, pl. 25 ("Lang 1"); Sampson 37:248; Tucker 27:298.)
98	Titan	Will Baughman, 141 W. Ave. 30, Los Angeles 31	23	3N	12W	SB proj.	Ridge south of Monte Cristo Creek, about 10½ airline miles southeast of Acton. Body of titaniferous magnetite, with chlorite and hornblende enclosed in anorthosite, traceable 1,000 ft. in length, up to 200 ft. in width. Estimated reserve: 250,000 tons carrying 11-25% TiO_2. No development. Idle. (Baughman: personal communication 1952; Miller 34; Oakeshott 48:259, pl. 25 ("Alder Creek 1" and "Mt. Gleason 7"); Sampson 37:196, map; Tucker 27:296-297.)
	Titian						See Iron Blossom. (Oakeshott 48:257; Tucker 27:298.)
	Trail Canyon 1 deposit						See Little Tujunga 8 deposit. (Oakeshott 48:258.)
99	Trail Canyon 2 deposit	Undetermined	12 7	3N 3N	14W 13W	SB SB proj.	North side of Pacoima Canyon, about 9 airline miles southwest of Acton. Titaniferous magnetite in altered pyroxenite accompanied by irregular masses of quartz within gabbro. Estimated reserve: 6,000,000 tons carrying 5-15% TiO_2. No production. Idle. (Oakeshott 48:258, pl. 25.)
	Trail Canyon 3 deposit	Undetermined	30	4N	13W	SB	Head of Bear Canyon, about 7½ airline miles southwest of Acton. Titaniferous magnetite-chlorite rock in small outcrops in anorthosite; granite pegmatite nearby. Estimated reserve: 5,000 tons carrying 5% TiO_2. No production. Idle. (Oakeshott 48:258, pl. 25.)

TITANIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
101	Trail Canyon 4 deposit	Undetermined	18	3N	13W	SB proj.	West side Slaughter Canyon, about $10\frac{1}{2}$ airline miles southwest of Acton. Titaniferous magnetite in chloritized pyroxenite in anorthosite and diorite gabbro. Shallow prospect adit. Estimated reserve: 300,000 tons carrying 5% TiO_2. No production. Idle. (Oakeshott 48:258, pl. 25.)
102	Trail Canyon 6 deposit	Undetermined	12	3N	13W	SB proj.	South side of head of Pacoima Canyon, about 7 airline miles west of Acton. Small percentage of titaniferous magnetite in thin ultrabasic body in diorite-gabbro. Estimated reserve: 100,000 tons carrying 10% TiO_2. No production. Idle. (Oakeshott 48:258, pl. 25.)
103	Trail Canyon 7 deposit	Undetermined	2	3N	13W	SB proj.	Head of Chimney Canyon, about $6\frac{1}{2}$ airline miles south of Acton. Massive titaniferous magnetite in anorthosite. Estimated reserve: 300,000 tons carrying 5% TiO_2. No production. Idle. (Oakeshott 48:258; pl. 25.)

TUNGSTEN

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Sierra Vista	Howard J. Dilworth, 436 Sierra Vista Ave. Monrovia (1953)	18	1N	10W	SB	North wall of Spanish Canyon, 2 airline miles northeast of Monrovia. Scheelite occurs in calc-silicate hornfels. Undeveloped prospect. Idle.

TUNGSTEN PROCESSING PLANTS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Dunham Tungsten Custom Mill	P.V. Salena, Clayton Dunham, and W.B. Fendry. Plant at 3156 San Fernando Blvd., Los Angeles					Custom mill for tungsten ores. Capacity 30 tons per day when last reported to be active in 1942.
	Gage Ore Testing Plant	Francis Gage, 1557 So. Fairfax Ave., Los Angeles (1953)					Hi-Grade gold mine property 3 miles northwest of Acton. Gold and tungsten bearing ores tested to determine suitable milling processes. Active in 1953.
	Los Angeles Tungsten Co. Plant	Los Angeles Tungsten Co., 517 E. 31st St., Los Angeles, (partnership of Paul S. and Percy Jones, John B. Gardetto and Peter Berta.)					Plant for concentrating scheelite ores and producing tungstic oxide. Active 1941-42 but defunct since early 1940's.
	Pacific Metallurgical Products Co. Plant	Pacific Metallurgical Products Co., 740 N. Georgia Ave., Azusa					Tungsten powder produced from tungsten-bearing concentrates. Active in 1953.
	Sun Valley Tungsten Co. Mill	Sun Valley Tungsten Co., 11370 Pendleton St., Sun Valley					Custom mill for tungsten ores. Table concentrating, drying, roasting,and magnetic separating equipment. Mill capacity about 25 tons per day in 1952. Active in 1953.
	Tungsten Processing Co. Mill	Tungsten Processing Co., 8855 Dice Rd., Los Nietos					Custom mill for tungsten ores. Plant shut down for moving in mid-1953.
	Western Metallurgical Products Co. Plant	Western Metallurgical Products Co., 9553 E. Rush St., El Monte					Tungstic oxide produced from tungsten-bearing concentrates. Active in 1953.

NONMETALLIC MINERALS

ASBESTOS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
104	Fiber Queen	Herman Mangold, General Delivery, Olive View (1929); Ray I. Underwood (1940); Blakemore E. Thomas and J.H. Berg (1951).	16	3N	15W	SB	Western San Gabriel Mts., about 4 airline miles northwest of San Fernando. Short-fiber chrysotile (?) asbestos in shear zone in chloritized shale. Developed by 80-ft. shaft, 320-ft. adit, now caved. Fifty tons reported mined in 1929 for use in pipe insulation. Long idle. (Herman Mangold: personal communication 1951.)

BARITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	San Dimas	W.G. Fields, H.E. Howard, C. Fairbanks, San Dimas (1921)	23	1N	9W	SB	West fork San Dimas Canyon, 8 miles northwest of San Dimas. Massive outcrop of white barite, 6-8 ft. wide, 50 ft. long, reported to assay 85-87% barium sulfate. Development undetermined. Small tonnage reported shipped about 1915. Idle for years. (Bradley 30:50; Merrill 19:480; Sampson 37:200; Tucker 21:317; 27:318.)

BORAX

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
105	Lang (Sterling)	Pacific Coast Borax Co., (Div. of Borax Consolidated, Ltd.) 630 Shatto Pl., Los Angeles. During main period of operation prior to World War I owner was Sterling Borax Co., Los Angeles	27,28, 29 32,33	5N	14W	SB	Tick Canyon, $3\frac{1}{2}$ airline miles north of Lang. (Eakle 11:179-189; Merrill 19:480; Newman 23b:31; Sampson 37:200-201; Tucker 21:317; 27:318-319; herein.)

CLAY PRODUCTS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Acme Brick Company	Acme Brick Co., Thos. Kelley, pres., Hill St. Bldg., Los Angeles (1927)	Approx.	2S	15W	SB proj.	Santa Monica. Red and yellow clay deposit 20-30 ft. thick used for common brick. Soft-mud process. Capacity 60,000 bricks per day; 40 employees in 1927. Long inactive. (Dietrich 28:94; Tucker 27:319.)
	Anderson & Sandquist	Anderson & Sandquist East Main St. Pottery Co., 2009 E. Main St., Los Angeles (1906)	23?	1S	13W	SB proj.	Boyle Heights. Flower pots and ollas produced (1906). Long inactive. (Aubury 06:213.)
106	Angulo Tile Co.		10	1N	16W	SB proj.	Reseda, southeast corner of Kittridge St. and Vanalden Ave. (Dietrich 28:97; plate 5 herein.)
107	Atkinson Brick Co.		16	3S	13W	SB proj.	Northwest Compton, west of Central Ave., 1/4 mile north of Rosecrans Ave. (Pac. Coast Ceramic News 53:22,27; plate 5 herein.)
108	Atlas Sewer Pipe Co.		32	2S	11W	SB proj.	Northeast Santa Fe Springs, west corner of Barton Rd. and Painter Ave. (plate 5 herein.)
	J.A. Bauer Pottery Co.	J.A. Bauer Pottery Co. 415 W. Ave. 33, Los Angeles (1953)	(See Simons Brick Co., Santa Monica pit.)				Clay products manufacturing plant now using clay from various localities. Bought clay from Santa Monica pit of Simons Brick Co. (which see) in 1907-1942; operated pit 1942-1948. (Boalich 20:50; Dietrich 28:98; Merrill 19:496.)
	Berg & Loyne's Brickyard	Berg & Loyne, 125 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles. Wood-burning open kiln, 8,000 bricks per day capacity, put out 1,500,000 bricks in 1895; 10 employees. Long inactive. (Crawford 96:614.)
	Berg & Oxby (Berg & Oby)	Berg & Oxby, 615 Lankershim Bldg., Los Angeles (1906)	21	1S	13W	SB proj.	Southern edge of Elysian Park, College St. at Depot St. Stiff-mud brick plant, steam driers, open kilns; 30 employees in 1906. Inactive since prior to 1919. (Aubury 06:243-244; Merrill 19:493.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bitumenized Brick & Tile Co.	Bitumenized Brick & Tile Co., 610 S. Main St., Los Angeles	(See Simons Brick Co. Simons plant.)				Manufacturer of bitumenized car block at Simons plant of Simons Brick Co. (which see). Common red brick boiled in bitumen to gain elasticity for use under rails. Irregular output in 1920. Long inactive. (Boalich 20:50.)
109	Builders Brick Co.		35	3S	14W	SB proj.	Northwest corner of 178th St. and Western Ave., $1\frac{1}{2}$ miles southwest of Gardena. (Plate 5 herein.)
	California Brick & Tile Co.						See Valley Brick & Supply Co. (Dietrich 28:98-99.)
	California Clay Manufacturing Co.						See Pacific Clay Products Co. - Slauson plant. (Aubury 06:213; Boalich 20:57; Merrill 19:496.)
	Capitol Steam Brick Works	E. Simons, 125 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles. Open kiln, capacity 40,000 bricks per day, operated in 1896; 40 employees. Long inactive. (Crawford 96:614.)
110	Castaic Brick Co. (Southern California Brick Co.)		13	5N	17W	SB	Southwest side of mouth of Grasshopper Canyon, 5 airline miles north of Castaic. (Dehlinger 52:11; plate 5 herein)
	City Brick Co.	City Brick Co., 85th St. and Vermont, Los Angeles (1927)	25	2S	14W	SB	Los Angeles, between 85th and 86th Sts. (Manchester Blvd) between Vermont and Western Aves., at 1900 Manchester Blvd., about 4 miles east of Inglewood. Sandy loam used for low-strength common brick by soft-mud process. Horse scrapers, 6-brick press, open kilns. Capacity undetermined. Active 1928; long idle. (Dietrich 28:100; Tucker 27:319.)
	City Brick Co.	City Brick Co., A.A. Hubbard, mgr., 125 W. Second St., Los Angeles (1896)	21(?)	1S	13W	SB proj.	Los Angeles, College St. south of Elysian Park. Wood-fired open kilns producing 38,000 bricks per day in 1896; 35 employees. Long inactive. (Crawford 94:381; 96:614.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
111	Coast Brick Co.	Lawrence I. Liston Co., 17720 Prairie Ave., Torrance (1953)	34	3S	14W	SB proj.	East side of Prairie Ave., between 174th and 182nd Sts., about midway between Torrance and Lawndale. Several pits now filled or converted to fish ponds on property of foundry sand processing plant. Brick production ceased in 1945 when plant was moved to Corona, Riverside County, where it is known as Liston Brick Co.
112	Davidson Brick Co. (Metallic Brick Co.)		29,32	1S	12W	SB	East Los Angeles, southern base of Repetto Hills at south side of mouth of deep canyon at end of Ford Blvd. (Boalich 20:56; Dietrich 28:100-101; Tucker 27:319; plate 5 herein.)
	Davin's Brickyard	P. Davin, corner Saratoga and Brooklyn Sts. Boyle Heights (1896)	Undetermined				Los Angeles, Boyle Heights. Open kiln of 12,000 bricks per day capacity active 1896; 12 employees. Long inactive. (Crawford 96:614-615.)
	Eureka Brick Co.	Eureka Brick Co., W.R. Gleason, supt., 127 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles. Open kiln active in 1896; capacity 18,000 bricks per day; 15 employees. Long inactive. (Crawford 96:615.)
	Forrester's Brickyard	C. Forrester, 125 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles. Open kiln with 8,000 bricks per day capacity active with 6 employees in 1896. Long inactive. (Crawford 96:615.)
	Furlow Pressed Brick Co.	Furlow Pressed Brick Co., 2001 San Pedro St., Los Angeles (1919)	5	2S	13W	SB proj.	Los Angeles, vicinity of Washington Blvd. and San Pedro St. Producers of sandlime brick, inactive since prior to 1919. (Merrill 19:493.)
	Gamble's Brickyard	J.M. Gamble, Garvanza (1896)	Undetermined				Garvanza (just north of Los Angeles). Wood-fired open kiln, capacity 8,000 bricks per day; 8 employees in 1896. Long inactive. (Crawford 96:615.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
113	Gladding McBean-Pico pit	Gladding McBean & Co., 2901 Los Feliz Blvd., Los Angeles 26 (1953)	7	2S	11W	SB proj.	East side of San Gabriel Wash west of corner of Beverly Blvd. and Guirado Ave. (Pioneer), about 1 mile east of Pico. Twenty acre deposit of red-burning common clay, 10-36 ft. thick, seasonally active since 1927. Bulldozers pneumatic-tired scrapers, and scoop loaders fill trucks for haul to plant at Glendale.
114	Gladding McBean-Santa Monica pit (Los Angeles Pressed Brick Co.)	Gladding McBean & Co., 2901 Los Feliz Blvd., Los Angeles 26, (1953)	5	2S	15W	SB proj.	Santa Monica, between 26th St. and Cloverfield Rd., on both sides of Colorado Ave. Red-burning, brown common clay deposit 10-36 ft. deep covers 25 acres. Plant constructed in 1906 recently produced only sewer pipe. Inactive 1952 but reopened in 1953. Eleven downdraft kilns. Periodic production of clay for use in Glendale plant. (Aubury 06:214,246-248; Boalich 20:55-56; Dietrich 28:102; Merrill 19:491,494; Tucker 27:319.)
115	Higgins Brick & Tile Co.-Gardena plant		35	3S	14W	SB proj.	South side of 174th St., between Arlington St. and Casmir Ave., about $1\frac{1}{2}$ miles southwest of Gardena. (Plate 5 herein.)
116	Higgins Brick & Tile Co.-Ramona yard (Tapper Brick Co.)		29	1S	12W	SB	East Los Angeles, mouth of canyon just south of Ramona Blvd., about $\frac{1}{2}$ mile east of Eastern Ave. overpass, about $2\frac{1}{2}$ miles west of Monterey Park. Plate 5 herein.)
117	Higgins Brick & Tile Co.-Santa Monica yard (Pacific Brick Co., Western Brick Co.)		5	2S	15W	SB proj.	Santa Monica, southeast side of Colorado Ave. between 26th St. and Harvard St. (Dietrich 28:122-123; Tucker 27:319; plate 5 herein.)
	Houlahan & Griffith's yard	Houlahan & Griffith, 208 Stinson Block, Los Angeles (1896)	Undetermined				Inglewood. Two continuous kilns, capacity 12,000,000 bricks per year in 1896; 60 employees. Long inactive. (Crawford 96:615.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hubbard & Chamberlain	R.M. Hubbard, La Brea Ave. near Wilshire Blvd., Los Angeles (1919)	21(?)	1S	14W	SB proj.	Los Angeles, Pico Heights. La Brea Ave. near Wilshire Blvd. Common brick made by soft-mud process. Capacity 40,000 bricks per day in 1906; 30 employees. Long inactive. (Aubury 06:244; Merrill 19:493.)
	Independent Brick Co.	Independent Brick Co., M. Flint, pres., 607½ S. Broadway, Los Angeles (1906)	28(?)	2S	14W	SB proj.	Inglewood, on Santa Fe Railroad. Clay 10-13 ft. deep with sand and gravel intermixed. Raymond roll crusher; stiff-mud process; steamheated tunnel drier; open and downdraft kilns with capacity of 60,000 bricks per day; about 30 employees in 1906. Long inactive. (Aubury 06:244.)
	J. Jensen	J. Jensen, West Pico St., Los Angeles (1906)	Undetermined				Los Angeles, Pico Heights. Eight-acre clay deposit. Clay ground in disintegrator; soft-mud process. Capacity 40,000 bricks per day in 1906; 20 employees. Long inactive. (Aubury 06:244; Crawford 96:615; Merrill 19:493.)
	Joyce Brick Co.	T.F. Joyce, 125 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles, near Buena Vista St. Plain bricks manufactured in continuous kiln; capacity 24,000 bricks per day in 1896; 30 employees. Long inactive. (Crawford 94:381; 96:615.)
118	K & K	Keller & Kubach, C.J. Kubach, pres., 801 Merchants National Bank Bldg., Los Angeles (1928)	21	1S	13W	SB proj.	Elysian Park, Los Angeles, southwest corner of Bishops Rd. and Effie St. Thirty-eight acre deposit of Miocene Puente blue and gray plastic shale 10-20 ft. thick made into brick by stiff mud process; steam-heated drier; open kilns. Capacity 75,000 bricks per day in 1906; 34 employees. Capacity 75,000 bricks per day in 1928 with 35 employees. Inactive since about 1929. (Aubury 06:244; Boalich 20:51; Dietrich 28:104; Merrill 19:491,493; Tucker 27:319.)
	Karr Frampton & Co's Brickyard	Karr Frampton & Co., 125 W. Second St., Los Angeles (1896)	Undetermined				Los Angeles. Open kiln; capacity 16,000 bricks per day (1896); 18 employees. Long inactive. (Crawford 96:615.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Linderman & Decker Co.	Linderman & Decker Co., Lomita (1928)	Undetermined				Harbor City. Ten-acre deposit of red clay 10-15 ft. deep under 1-2 ft. of gravel, mined and shaped by hand into roofing tile. Sun dried and fired in gas-burning kiln. Only two kilns fired (1928). Long inactive. (Dietrich 28:104-105.)
	Long Beach Brick Co. (Lynn Brick Co.)	Long Beach Brick Co., H.A. Havner, pres., 154 Elm St., Long Beach (1928)		4,5S	12W	SB proj.	Long Beach, east end of East First St., at Alamitos Bay and East 7th St. at Ximeno Ave. (Also owned Lynn Brick Co. pit at Highway 101 and Normandie Ave.) Common red brick made of sandy clay from pit 20-25 ft. deep. Mined with scraper; belt conveyor to plant. Stiff-mud process; bricks air dried and fired in field kilns. Capacity 45,000 brick per day (1928); 25 employees. Long inactive. (Boalich 20:51-52; Dietrich 28:105; Merrill 19:493; Tucker 27:319.)
119	Los Angeles Brick Co. - Chavez Canyon yard (Los Angeles Brick & Clay Products Co.)	Los Angeles Brick Co., 1078 Mission Rd., Los Angeles (1928) (Los Angeles Brick & Clay Products Co., same address, 1953).	21	1S	13W	SB proj.	Los Angeles, south side of Elysian Park, southwest side of Chavez Canyon, just south of corner of Chavez Canyon Rd. and Paducah St., opposite Naval Armory. Miocene Puente shale, sand, and clay mined from hillside face about 1,000 ft. long, over 100 ft. high. Stiff-mud process; steam heated driers and open kilns. Red common brick and building tile produced; capacity 100,000 bricks per day (1920), or 80,000 bricks and 100 tons hollow building tile per day (1928). Active from prior to 1906 to about 1930. (Aubury 06: 246; Boalich 20:52; Dietrich 28:105,107; Merrill 19:491; Tucker 27:319.)
120	Los Angeles Brick Co. - Mission Road yard	Los Angeles Brick Co., 1078 Mission Rd., Los Angeles (1928) (Los Angeles Brick & Clay Products Co., same address, 1953)	25	1S	13W	SB proj.	East Los Angeles, Brooklyn Heights, south corner of Mission Rd. and Marengo St. Clay deposit 25-30 ft. thick overlies 5-6 ft. of sand. Common brick produced by soft mud process; shifted in mid 1920's from continuous kiln drying and firing to air drying and field kilns. Capacity 25,000-30,000 bricks per day (1920); 80,000 bricks in

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
120	Los Angeles Brick Co. - Mission Road yard (contd)						1928. Active from prior to 1906 until clay exhausted in 1929. Property now sales yard for clay products manufactured in Riverside County. (Aubury 06:244,246; Boalich 20:52; Dietrich 28:105; Merrill 19:490-491; Tucker 27:319.)
121	Los Angeles Brick Co. - Seventh Street yard	Los Angeles Brick Co., 1078 Mission Rd., Los Angeles (1928) (Los Angeles Brick & Clay Products Co., same address, 1953.)	34,35	1S	13W	SB proj.	Los Angeles, Boyle Heights, east side of Los Angeles River, just south of 7th St., about 1/8 mile west of Boyle Ave. Boyle Heights terrace clay about 30 ft. deep used for brick. Soft-mud process; air drying; continuous and open kilns. Active prior to 1906; inactive since prior to 1919. (Aubury 06:246; Boalich 20:53; Dietrich 28:107; Merrill 19:491; Tucker 27:319.)
122	Los Angeles Pottery Co.	J.M. Mathews, 625 Griffin Ave., and Alhambra St. (?) Los Angeles (1906)	23	1S	13W	SB proj.	Los Angeles, Boyle Heights, Griffin Ave. at Alhambra St. Boyle Heights clay used principally for flower pots. Active in 1906; long inactive. (Aubury 06:214.)
	Los Angeles Pressed Brick Co.						See Gladding McBean - Santa Monica pit. (Works at Alhambra Ave. and Date St., Los Angeles, was a manufacturing plant only, using clays from several localities). (Aubury 06:214,246-248; Boalich 20:55-56; Dietrich 28:102; Merrill 19:491,494; Tucker 27:319.)
	Los Angeles Stoneware & Sewer Pipe Co.						See Pacific Clay Products Co. - Lincoln Heights plant. (Aubury 06:214, 216; Merrill 19:496.)
	R. Loynes	R. Loynes, Long Beach (1906)	34(?)	4S	12W	SB proj.	Northeast of Long Beach, east of Anaheim Rd. Brick made from 10-acre clay deposit, burned in open kilns. (1906). Long inactive. (Aubury 06:248.)
123	Lynn Brick Co. (Long Beach Brick Co.)		36	4S	14W	SB proj.	South Harbor City, southwest corner of Normandie Ave. and Pacific Coast Highway. (Dietrich 28:105; plate 5 herein.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
124	Malibu Potteries	Marblehead Land Co., R.B. Keeler, mgr., Box 518, Santa Monica (1928)	33	1S	17W	SB proj.	North side Pacific Coast Highway, 1-3/4 miles west of mouth of Las Flores Canyon, about 9 miles west of Santa Monica. Local clays blended with imported clays for use in plain and decorated terra cotta wall tile. Tile auger and hand-pressed shapes. Three up-draft kilns. Active 1928 but inactive since depression. (Dietrich 28:107.)
	Metallic Brick Co.						See Davidson Brick Co. (Boalich 20:56.)
125	Mission Brick Co.	Mrs. A.E.L. Anderson 755½ Santa Monica Blvd., Los Angeles (1928)	9	1N	15W	SB proj.	Van Nuys, east side of Sepulveda Blvd., north of Southern Pacific Railroad tracks, between Oxnard and Erwin Sts. Deposit of red clay 5-20 ft. thick mined by scrapers, hauled to plant by conveyor belt. Soft-mud process used; 20,000 common brick produced per day; dried in sheds, fired in field kilns. 20 employees during 4-month operating season (1928). (Dietrich 28:107,109.)
	Monarch Brick Co's yard	Whitman & Workman, 127 W. 2nd St., Los Angeles (1896)	Undetermined				Los Angeles. Brick produced in open kilns, capacity 34,000 bricks per day (1896); 30 employees. Long inactive (Crawford 96:615.)
	Owens Brick Co.						See Valley Brick & Supply Co. (Dietrich 28:98-99.)
	Pacific Brick Co.						See Higgins Brick & Tile Co. - Santa Monica yard.
	Pacific Clay Products Co. - Lincoln Heights plant (Los Angeles Stoneware & Sewer Pipe Co., Pacific Sewer Pipe Co.)	Pacific Clay Products Co., 306 W. Ave. 26, East Los Angeles (1953)					East Los Angeles Ave. 26 and Humboldt Ave. Manufacturing plant only; discontinued in 1952 except for sales yard and main office. (Aubury 06:214-216; Boalich 20:57; Dietrich 28:111-114; Merrill 19:496.)
126	Pacific Clay Products Co. - Plant No. 6, Los Nietos (Pacific Sewer Pipe Co.)		31	2S	11W	SB proj.	Los Nietos, Norwalk Blvd. between Smith Ave. and Southern Pacific railroad tracks about 1/4 mile south of Los Nietos Rd. (Boalich 20:58; Dietrich 28:114-116; Merrill

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
126	Pacific Clay Products Co. - Plant No. 6, Los Nietos (Pacific Sewer Pipe Co.) continued						19:496; Tucker 27:319; plate 5 herein.)
127	Pacific Clay Products Co. - Slauson plant. (California Clay Manufacturing Co., Pacific Sewer Pipe Co.)		17	2S	13W	SB proj.	Los Angeles, southwest corner of 56th St. and McKinley Ave. Manufactured brick (soft-mud and stiff-mud processes), sewer pipe, electrical conduit, but shut down about 1930 except for sales yard. Small proportions of local clay mixed as "grog" in imported clays. (Aubury 06:213; Boalich 20:57; Dietrich 27:116; Merrill 19:496.)
	Pacific Sewer Pipe Co.						See Pacific Clay Products Co. - Plant No. 6. (Boalich 20:57-58; Dietrich 28:109-116; Merrill 19:496.)
128	Pay Brickyard	C. Pay, Mott & Seventh Sts., Boyle Heights (1896)	2	2S	13W	SB proj.	Boyle Heights, Seventh at Mott St. Wood-burning open kilns used to produce 18,000 bricks per day in 1896; 20 employees. Long inactive. (Crawford 96:615.)
	Pierson & Anderson's Brickyard	C. Schroder, Pico Heights (1896)	Undetermined				Los Angeles. Open kiln used to produce 8,000 bricks per day in 1896; 8 employees. Long inactive. (Crawford 96:615.)
129	Pomona Brick Co.		25 36	1S 1S	9W 9W	SB SB proj.	Pomona, southwest corner of Ninth St. and Buena Vista, at north edge of Puente Hills. Abandoned pit at plant site; active pit about 3/4 mile south of plant on hill slope. (Aubury 06:248; Boalich 20:58; Dietrich 28:116-117; Merrill 19:493; plate 5 herein.)
130	San Valle Tile Kilns		10	1N	16W	SB proj.	Reseda, east side of Wilbur Ave. between Kittridge St. and Victory Blvd. (Plate 5 herein.)
	Santa Catalina Island deposits	Santa Catalina Island Co., Avalon (1953)	Approx	9S	14W	SB proj.	Santa Catalina Island, several deposits in Avalon Canyon, near Pebbly Beach, and others near Avalon. Red-burning

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Santa Catalina Island deposits (continued)						clay used for brick, roof tile, hollow tile, and decorative tile. Plant at Avalon 1928 (?)-1940; 35 employees. (Renton, Malcolm: personal communication, 1952.)
131	Santa Monica Brick Co.	Santa Monica Brick Co., E.A. Douglas, pres., 23rd and Michigan Sts., Santa Monica (1928)	5	2S	15W	SB proj.	Santa Monica, north corner of Michigan Ave. and Cloverfield Rd. (23rd St.). Plastic, red-burning clay from pit 45 ft. deep (1927) used for common brick, red face brick, roofing tile, and red floor tile. Stiff-mud process used for brick; tile machines for tile. Hot-air drier, field kilns used. Capacity 75,000 bricks, 40 squares of tile per day (1928); 60 employees. (Dietrich 28:118-119.)
132	Simons Brick Co. - Boyle plant	Simons Brick Co., Walter R. Simons, pres., 125 W. Third St., Los Angeles (1928)	2,3	2S	13W	SB proj.	Boyle Heights, west side of Boyle Ave. opposite Opal St. between 7th and 8th Sts. Sandy loam 30 ft. thick used for hollow tile, roof tile, ruffle brick (1920); later roofing tile only from Santa Monica clay (1928). Used steam shovel, horse teams; soft- and stiff-mud processes; shed drying, 12 downdraft kilns and field kilns. Capacity 25,000 bricks per day (1896); 8,000 hollow tile per day (1920); 35 employees. (Aubury 06:248; Boalich 20:58-59; Dietrich 28:119; Merrill 19:490; Tucker 27:319.)
	Simons Brick Co. - Inglewood plant	Simons Brick Co., 125 W. Third St., Los Angeles (1906)	28,29 (?)	2S	14W	SB proj.	Inglewood. Bricks made in continuous kiln (1906). Long inactive. (Aubury 06:249.)
133	Simons Brick Co. - Montebello plant	Simons Brick Co., 125 W. Third St., Los Angeles (1906)	11	1S	12W	SB proj.	Montebello, Greenwood Ave. and Union Pacific Railroad tracks. Bricks made by stiff-mud process about 1906-1935.
	Simons Brick Co. - Pasadena plant	Simons Brick Co., 125 W. Third St., Los Angeles (1906)	11(?)	1S	12W	SB	Pasadena, on South Franklin Ave. Bricks made by soft-mud process; air dried; fired in open kilns. Capacity 36,000 bricks per day (1906); 35-40 employees. Inactive since prior to 1919. (Aubury 06:248-249; Merrill 19:490.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
134	Simons Brick Co. - Santa Monica plant	Simons Brick Co., 125 W. Third St., Los Angeles (1928)	4,5	2S	15W	SB proj.	Santa Monica, between Virginia and Michigan Aves., Stewart (28th) and Frank (25th) Sts. Brown common clay, 25-30 ft. deep, used for common brick, both by soft- and stiff-mud processes; fired in field kilns. 35 employees (1920) Active from about 1906 to about 1935. Later provided clay for pottery manufacturing plants. (Aubury 06:249; Boalich 20:60; Dietrich 28:119; Merrill 19:490.)
135	Simons Brick Co. - Simons plant		15,16	2S	12W	SB proj.	Montebello, several large pits west of Vail Ave. between Santa Fe railroad tracks and Beach St. on both sides of Washington Blvd. (Boalich 20:60; Dietrich 28:119-120; Tucker 27:319; plate 5 herein.)
	Southern California Brick Co.	J.H. Marks, 304 Hellman Bldg., Los Angeles (1906)	2(?)	2S	13W	SB proj.	Los Angeles, Boyle Heights, Mott St. and Stephenson Ave. (?). Bricks made by soft-mud process, field kilns. Capacity 36,000 bricks per day. 35 employees (1906). Inactive since prior to 1919. (Aubury 06:249; Merrill 19:488,493.)
	Southern California Brick Co.						See Castaic Brick Co.
	Southern California Pottery Works (J.F. Tomaseck)	Tomaseck Sons, 882 E. 48th St., Los Angeles (1919)	Undetermined				Los Angeles. Local clay from Boyle Heights blended with Riverside County clays to make earthenware stove linings, flue thimbles, assayers' furnaces, and muffles (1906-1919) Long inactive. (Aubury 06:216; Merrill 19:499.)
	Southwest Brick Co.						See Western Ave. Brick Co.
136	Standard Brick Co. - Boyle Heights plant	Standard Brick Co., J.V. Simons, pres., 102 Stimson Bldg., 129 W. Third St., Los Angeles (1928)	10,11	2S	13W	SB proj.	Los Angeles, Boyle Heights, between Los Angeles River and Soto St., opposite Lugo St. Common red brick and sewer brick made from clay loam, 15-18 ft. thick. Soft-mud process; air drying; field kilns. Capacity 36,000 bricks per day (1919); 35 employees. Last reported active in 1928; long inactive. (Aubury 06:249; Boalich 20:62;

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
136	Standard Brick Co. - Boyle Heights plant (continued)						Dietrich 28:120; Merrill 19:493; Tucker 27:319.)
137	Standard Brick Co. - Inglewood yard	Standard Brick Co., J.V. Simons, pres., 102 Stinson Bldg., 129 W. Third St., Los Angeles (1928)	28	2S	14W	SB proj.	Inglewood, Eucalyptus Ave. north of Santa Fe Railroad tracks. Common and sewer brick made from sandy clay by soft-mud process. Capacity 40,000 bricks per day (1920). Long inactive. (Boalich 20:62; Dietrich 28:120.)
	Star Brick & Tile Co.						See Western Ave. Brick Company.
	Tapper Brick Co.						See Higgins Brick & Tile Co. - Ramona yard.
	Taylor Tile Co.						See Atlas Sewer Pipe Co.
	J.F. Tomaseck						See Southern California Pottery works. (Merrill 19:499.)
138	Torrance Brick Co. - Monterey Park plant, No. 2	Torrance Brick Co. T.H. Reed, pres., Torrance (1928)	26	1S	12W	SB	East Monterey Park, Graves and Jackson Aves. Common brick, hollow tile, and red face brick produced from deposit of clay shale 20-30 ft. thick. Capacity 60,000 bricks per day, or equivalent (1928); 40 employees. Inactive. (Dietrich 28:120-121.)
	Torrance Brick Co. - Torrance plant No. 1	Torrance Brick Co., T.H. Reed, pres., Torrance (1928)	14	4S	14W	SB proj.	Torrance, south of Plaza del Amo Blvd., opposite Abalone Ave. Common red brick made from red and yellow plastic clay 30 ft. thick; stiff-mud process; field kilns. Capacity 60,000 bricks per day in 1928; 30 employees. Inactive since early 1930's. (Dietrich 28:120.)
139	Valley Brick & Supply Co. (California Brick & Tile Co., Owens Brick Co.)		9	1N	15W	SB proj.	Van Nuys, between Kester Ave. and Sepulveda Blvd., just north of Southern Pacific Railroad tracks. (Dietrich 28: 98-99; plate 5 herein.)

CLAY PRODUCTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
140	Western Ave. Brick Co.		35	3S	14W	SB proj.	South Gardena, west side of Western Ave., (pit west of Builders Brick Co. pit) about midway between 174th and 182nd Sts. (Plate 5 herein.)
141	Western Brick Co. - Elysian Park plant	Western Brick Co., G. A. Wild, pres., Room 605, 126 W. Third St. Los Angeles (1928)	21	1S	13W	SB proj.	Los Angeles, Elysian Park, between Home Pl. and Shoreland south of Garibaldi. Common red brick made from Miocene Puente shale and sandy shale blended with other clays. Active from 1916 to about 1930, capacity 10,000,000 bricks per year (1928). (Dietrich 28:122; Tucker 27:319.)
	Western Brick Co. - Santa Monica plant						See Higgins Brick & Tile Co. - Santa Monica plant. (Dietrich 28:122.)

FULLER'S EARTH

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Overman	R.E. Overman, 117½ Commercial St., Los Angeles (1919)	?	4N	16W	SB proj.	Six miles west of Saugus. Occurrence only, no development reported. (Merrill 19:500.)

COAL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Carbon Hill deposit	Carbon Hill Oil & Coal Co., A.S. Longley, pres., 338 So. Broadway, Los Angeles (1896)	10?	3N	16W	SB	Low hills about $1\frac{1}{2}$ miles southwest of Newhall. Bituminous stratum 32 in. thick explored by 25° incline. In part lignitic in appearance. Reported to contain 72% carbonaceous matter, 25% ash. No production. Idle since prior to 1919. (Crawford 96:54; Merrill 19:499; Preston 90a:204.)
	Unnamed	Undetermined	32?	1S	16W	SB	About 1/3 mile from beach, about 4 miles west of Santa Monica. Bituminous shale reported. Explored by 200-ft. adit in 1889. No production. Long idle. (Hoots 31:109-110; Merrill 19:499; Preston 90a:208.)

DIATOMACEOUS EARTH

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
142	Banning Quarry	Banning & Co., 504 Pacific Electric Bldg., Los Angeles (1919). Santa Catalina Island Co. (1953)	30(?)	8S	15W	SB proj.	Santa Catalina Island, about 1 mile east of Isthmus Cove Diatomaceous earth beds reported as thick as 75 ft. Developed by surface operations. Yielded 5 tons of "French chalk" in 1895, 5 tons of infusorial earth in 1895-1896. Experimental production in 1937. Idle. (Aubury 06:291; Crawford 94:406; 96:642, 643; Merrill 19:507; Renton, Malcom:personal communication 1953; Sampson 37:202; Tucker 27:321.)
143	Dicalite (Palos Verdes Ranch)	Dicalite Div. of Great Lakes Carbon Corp., 612 S. Flower, Los Angeles	28	4S	14W	SB proj.	Northeast side of Palos Verdes Hills, about 1/2 mile south of Walteria. (Aubury 06:291-292; Merrill 19:507; Oakeshott 50:152; Preston 90b:282; Sampson 37:201-202; Tucker 27:321; herein.)
144	Featherstone deposit	Dailey S. Stafford, 242 E. Center St., Covina. Operated by Featherstone Co., Robert Burhans, Jr., pres. 911 Mateo St., Los Angeles (1927)	17,20	1S	9W	SB proj.	North side San Jose Hills $2\frac{1}{2}$ miles east of Covina. Beds of Miocene diatomaceous earth 30-150 ft. thick with clay and conglomeratic beds. Mined from 3 quarries within an area $\frac{1}{2}$ by $\frac{1}{4}$ mile. Diatomaceous earth and clay produced in 1920's and milled on the property for insulation and cement additive. Total production undetermined. Long idle. (Newman 23a:366-368; 23b:31; Sampson 37:202; Tucker 21:319; 27:319-321.)
	Palos Verdes Ranch						See Dicalite. (Aubury 06:291-292; Merrill 19:507; Preston 90b:282; Tucker 27:321.)
	Point Dume deposit	Undetermined	Approx.	2S	18W	SB proj.	Point Dume, about 17 miles west of Santa Monica. Large deposit of infusorial earth reported. No production. (Aubury 06:292; Merrill 19:507; Preston 90a:208; Sampson 37:202; Tucker 27:321.)

FELDSPAR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Caliproducts	Lenardo Ruiz, Acton (1937). Operated by Caliproducts Co., R.C. McInerny, pres., 1009 Spring Arcade Bldg., Los Angeles (1925)	15	4N	13W	SB	Soledad Canyon, about 1 mile west of Ravenna. East end of labradorite-rich zone extending from Lang east to Ravenna. Body of massive labradorite developed by several adits and open cuts; mined through 20-ft. adit and crosscuts. Undetermined tonnage treated in 100-ton grinding plant for use in glass and pottery in 1925. Long idle. (May be same as Ohio Silica deposit) (Sampson 31:417-418; 37:204; Tucker 27:323.)
	Chicago-Pacific	J.P. Monahan and J.G. Krown, Homer Laughlin Bldg., 315 S. Broadway Los Angeles (1937)	8,9, 15,16, 17	4N	14W	SB	Soledad Canyon, between Lang and Alpine. Zone of massive labradorite rock as much as 2 miles wide and traceable for 12 miles east of Lang, in metamorphic rocks of San Gabriel complex. Development, production, undetermined. Idle since prior to 1927. (Newman 23a:164-165; Sampson 31:418; 37:204; Tucker 23:323-324.)
	Duncan	Harry Duncan, Los Angeles (1937)	14,15	4N	13W	SB	South side of Soledad Canyon, about 2½ airline miles south of Acton. East end of labradorite-rich zone extending from Lang east to Ravenna. Production of 2,000 tons of labradorite reported in 1918 for use in electrical insulators. Long idle. (Sampson 31:418-419; 37:204; Tucker 27:324.)
145	Gates Chemical Co.	Gates Chemical Co., E.S. Gates, pres., 1204 W. 7th St., Los Angeles (1937)	15	4N	14W	SB	South of Alpine siding, Soledad Canyon, about 8 miles southwest of Acton. In anorthosite-rich zone extending from Lang east to Ravenna. Light-colored alumina silicate rock mined in 1917-1918 from open cut 150 ft. long and 20 ft. high for use in Gates' cleanser. Total production undetermined. Long idle. (Oakeshott 37:244-245; Sampson 31:419; 37:203-204; Tucker 27:324.)
146	Gordon	Leo I. Gordon, 6742½ Kraft Ave., North Hollywood (1939)	33	4N	13W	SB	Head of Pacoima Canyon, about 6 airline miles southwest of Acton. Body of white anorthosite in San Gabriel metamorphic complex. Forty tons mined from open cut in 1939 for ceramic use. Idle.

FELDSPAR (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
147	Labmert's Poultry Grits	Anton Lambert, Rt. 1, Box 261, Saugus (1951)	16	4N	14W	SB	Soledad Canyon, about 1 mile east of Lang. Body of white anorthosite in plagioclase-rich zone extending from Lang east to Ravenna. About 5-10 tons per month mined in open cut and ground for poultry grit. Intermittent activity since 1950.
148	Silica Mining & Products Co.	Silica Mining & Products Co., S.M. Clayman, pres., Los Angeles (1937)	31	5N	12W	SB	Northeastern Soledad Canyon about 1/2 mile northeast of Acton. Vein of silica and orthoclase feldspar 25 ft. wide dips 60° northwestward in granitic rock. White quartz with minor muscovite and hematite on footwall; pink orthoclase on hanging wall. Developed by open cut and shallow inclined shaft on vein; nearly all workings obliterated by 1953. Idle since undetermined tonnage shipped in 1926. (Sampson 31:419; 37:204; Tucker 27:324-325.)
	Stanley Alumina Silicate	George Stanley, Los Angeles (1937)	26,28	4N	14W	SB	Magic Mt., about 9 airline miles southwest of Acton. Body of labradorite in metamorphic rocks of San Gabriel complex. Exploration, production, undetermined. Long idle. (Sampson 31:419; 37:204; Tucker 27:324.)
149	Vail	Karl Vail, Suite 835, Security Bldg., Los Angeles 13 (1951)	13,14	4N	14W	SB	South side of Soledad Canyon, about 6½ airline miles southwest of Acton. In labradorite-rich zone extending from Lang east to Ravenna. Tested for use as expansion corrective for alkali cement aggregate in 1951. Undeveloped deposit. Idle.

FLUORITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Felix	Undetermined	Approx	1N	10W	SB	San Gabriel Mts., north of Azusa. Fine specimens of fluorite, in purple and green masses and cubes reported. No production. Idle. (Murdoch 48:146-147.)

GRAPHITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
150	American Graphite Co. (Kagel Canyon, Los Angeles Graphite Co., McAnany and Rice)	Goodan Company, Roger Goodan, pres., 2550 Aberdeen, Los Angeles 27 (1951). Operated by American Graphite Co. (later Los Angeles Graphite Co.) Albert Maltman, mgr., 211 Grant Bldg., Los Angeles (1921-1922)	28	3N	14W	SB	Head of Limerock Canyon, west of Little Tujunga Canyon, $4\frac{1}{2}$ airline miles east of San Fernando. Fine flakes of graphite disseminated through 10-20 ft. width of quartz-feldspar schist with concentrations of 7-15% graphite reported. Vein dips steeply and is traceable several thousand ft. Worked by 60-ft. adit and several open cuts. Fifty-ton flotation mill installed in early 1920's, now dismantled. Production undetermined but minor. Long idle. (Haley 22:59; Oakeshott 37:246; Sampson 37:195,205, map; Symons 30:154; Tucker 21:318, 27:325.)
	Big Tujunga Canyon deposit	Undetermined	Approx.	3N	13W	SB	About 4 miles up Big Tujunga Canyon, about $3\frac{1}{2}$ miles north of Sunland. Outcrop, not described. (Preston 90b:282.)
	Black Diamond	M.M. Souden and D.L. Porter, Los Angeles. Leased to Western Graphite Co., C.W. Jones, pres., 1023 W. 10th St., Los Angeles (1934)	33,34	7N	15W	SB	Northwest side Elizabeth Lake Canyon, 2 airline miles southwest of Hughes Lake, adjacent southwest of Western Graphite Co. mill. Graphite amphibole schist outcrop 6-20 ft. wide, traced about 2 miles through granitic rock. Graphite content reported 12-17%, in fragments smaller than 0.25 millimeter. Explored by several open cuts and adits as much as 150 ft. long. Small but determined production 1934 and 1935, treated in Western Graphite Co. flotation mill. Long idle. (Sampson 37:193; Tucker, W.B., unpublished report, 1934).
151	Black Lode	Gus Sharp, 1218 S. Walnut, San Gabriel, and Ben Jurgens, Venice (1940)	17	3N	14W	SB	South side of head of Pacoima Canyon, about $5\frac{1}{2}$ airline miles northeast of San Fernando. Graphite disseminated in limy schist of San Gabriel complex. Prospect only. Idle.
152	California Graphite Co., (Flake, Prince, San Francisquito Canyon deposit)	Lewis M. Mercer, Los Angeles (1952). Operated by California Graphite Co., O.M. Sou-	11,12	6N	15W	SB	Northwest side of San Francisquito Canyon, about 16 miles north of Saugus. Steeply dipping graphite schist 8-25 ft. wide traceable for more than a mile through weathered granitic rock. "Amorphous" graphite present in two zones

GRAPHITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
152	California Graphite Co., (Flake, Prince, San Francisquito Canyon deposit) (continued)	den, pres., 402 Bryson Bldg., Los Angeles (1923)					in concentrations as high as 17% graphite. Mined by open cuts and several hundred ft. of underground workings. Hauled to 50-ton dry-process mill by 1500 ft. aerial tramway. Ten tons of ore milled per day for local use in foundry facings, paint, and lubricants. Total production undetermined. Last reported activity in 1923. (Bradley 25: 52; Haley 22:59; Merrill 19:502-504; Newman 23a:221; 23b: 31; Sampson 37:205; Simpson 34:410; Tucker 21:318-319; 27:325-326.)
153	Champion	Andrew Thomasson, Rt. 1, Box 102, Saugus (1953). Leased to Daniel Webster, et al., 14906 Lemoli Ave., Gardena (1953).	28	5N	14W	SB	About 6 miles west of Acton. Graphite-bearing schist exposed in underground and surface workings of Champion gold mine (see in gold section); also exposed discontinuously for several thousand feet along strike of steeply dipping seams of schist as much as 6 ft. wide. Assays up to 15.62% graphite. Exploration and development work commenced early in 1953.
	Flake						See California Graphite Co. (Newman 23b:31.)
154	Gilman deposit	M.R. Gilman, 504 W. Avenue 37, Los Angeles (1937)	16	3N	14W	SB	South side of head of Pacoima Canyon, about $5\frac{1}{2}$ airline miles northeast of San Fernando. Graphite in lenses 2-4 ft. wide in limy schist of San Gabriel complex. Prospect only. Idle. (Sampson 37:205.)
	Helman	D.D. Helman, 2029 New Jersey St., Los Angeles (1906)	Approx.	7N	15W	SB	Near Elizabeth Lake. Showing of graphite. Prospect only. Long idle. (Aubury 06:280; Merrill 19:504; Tucker 27:327.)
155	Jamestown No. 2	Frank C. Gallagher and George R. Shepherd address undetermined (1948)	17	3N	14W	SB	South side of head of Pacoima Canyon, about $5\frac{1}{2}$ airline miles northeast of San Fernando. Graphite disseminated in limey schist of San Gabriel complex. Prospect only. Idle.

GRAPHITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Kagel Canyon						See American Graphite Co. (Sampson 37:205; Tucker 27:325)
	Los Angeles Graphite Co.						See American Graphite Co. (Haley 22:59; Tucker 27:325.)
	McAnany and Rice						See American Graphite Co. (Sampson 37:195, map.)
	Prince						See California Graphite Co.
	San Francisquito Canyon deposit						See California Graphite Co. (Sampson 37:205; Tucker 27: 325, 326.)
	Standard Graphite Co.						See Verdugo Mountain deposit. (Sampson 37:205; Tucker 27: 326.)
	Verdugo Canyon deposit	Undetermined	4	1N	13W	SB	Verdugo Canyon, about 3 miles north of Glendale. Stratum of "amorphous", soft graphite 20 ft. wide in micaceous schist. Reported to contain 60-70% carbonaceous material. Minor exploration workings. Production undetermined. Long idle. (Aubury 06:280; Merrill 19:504; Preston 90a: 207.)
	Verdugo Mountain deposit	J.E. Hostetter, 917 Washington Bldg., Los Angeles (1937) Leased to Standard Graphite Co., Glendale (1927)	29	2N	13W	SB	Verdugo Mts., just south of Tujunga, about 2½ miles northwest of Montrose. Graphite schist 7-30 ft. wide dips moderately in granite. Contains 10-15% graphite in small flakes with quartz, feldspar, little mica. Mined by open cut and 60-ft. adit. Four tons a day produced in 25-ton flotation mill (1927) for use in paint and foundry facing. Total production undetermined. Long idle. (Sampson 37:205; Symons 30:154; Tucker 21:319; 27:326.)
156	Western Graphite Co.	Western Graphite Co., C.W. Jones, pres., 337 W. Ave. 26, Los Angeles	27	7N	15W	SB	East side of Elizabeth Lake Canyon, about 1¼ airline miles southwest of Lake Hughes. Operated Black Diamond deposit discontinuously in 1934 and 1935. Fifty-ton flotation mill converted for custom milling of gold ores in

GRAPHITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
156	Western Graphite Co. (cont'd)						1935. Production undetermined. Idle since 1935. (Sampson 37:193,205; Tucker 38:12.)

GYPSUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
157	Alpine	New Alpine Gypsum Co., Kendall Delaney, pres. 720 No. Spring St., Los Angeles (1927). Operated by Alpine Plaster Co., 720 E. Colorado St., Pasadena (1906)	34,35	6N	12W	SB	South side of Anaverde Valley, about $\frac{1}{2}$ mile southwest of Palmdale. Gypsite beds 2-10 ft. thick overlie and truncate gypsiferous shale of Oligocene(?) Vasquez series. Mined by open cuts, now partly filled. Material used for plaster of paris, wall-plaster, and fertilizer. Inactive since 1915. See Fire Pulp Plaster. (Aubury 06:284-285; Crawford 94:324; 96:504; Hess 20:75-77; Merrill 19:504-505; Sampson 37:205; Simpson 34:412; Storms 93:248; Tucker 27:327; Ver Planck 52:57, pl. 1.)
	Charlie Canyon (San Francisquito Canyon) deposit	Fire Pulp Plaster Co., 750 So. Alameda St., Los Angeles (1919)	10	5N	16W	SB	Charlie Canyon, about 7 airline miles northeast of Castaic. Gypsum, reported of excellent quality, in small pockets and a vein 2-4 ft. wide in soft, jointed shale. Undetermined production in 1904-1905; idle since. (Aubury 06:285; Hess 20:75; Merrill 19:505; Sampson 37:205; Tucker 27:327; Ver Planck 52: pl. 1.)

GYPSUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
158	Fire Pulp Plaster (Palmdale)	Fire Pulp Plaster Co., 750 So. Alameda St., Los Angeles (1919)	34 or 35	6N	12W	SB	South side of Anaverde Valley, about $\frac{1}{2}$ mile southwest of Palmdale. Gypsiferous shale member of Oligocene (?) Vasquez series. Gypsum and shale interbedded in laminae as thick as 1 inch in zone 50-200 ft. thick. Gypsite beds 2-10 ft. thick truncate tilted shale formation. Mined by open cuts, now partly filled. Inactive since 1915. (See Alpine) (Hess 20:75-76; Ver Planck 52:57, pl. 1.)
159	Lang (Los Angeles Gypsum, Mint Canyon) deposit	Certainteed Products Corp., C.L. McDonald, pres., (1914)	29,30	5N	14W	SB	East side of Mint Canyon, about $3\frac{1}{2}$ airline miles north of Lang. Gypsiferous zone as much as 15 ft. thick in Oligocene (?) Vasquez formation dips moderately northward. Explored in 1920's and 1948 by open cut 150 yards long on outcrop. Production undetermined. Idle. (Aubury 06:286; Hess 20:77; Merrill 19:505-506; Preston 90a:195; Sampson 37:205, map; Tucker 27:327; Ver Planck 52:40, pl. 1.)
	Los Angeles Gypsum deposit						See Lang. (Sampson 37:map.)
	Mint Canyon deposit						See Lang. (Ver Planck 52:pl. 1.)
	Palmdale deposits						See Alpine, and Fire Pulp Plaster (Palmdale). (Hess 20:75; Simpson 34:412; Tucker 27:327; Ver Planck 52:57, pl. 1.)
	San Francisquito Canyon deposit						See Charlie Canyon deposit. (Aubury 06:285; Merrill 19:505; Sampson 37:205; Tucker 27:327.)

LIMESTONE

Map No.	Claim, mine, or group	Owner Name, address	Location Sec.	T.	R.	B & M	Remarks
160	Amercal	American Mining Co. Inc., Robert L. Griffin, pres., 16321 Lakewood, Bellflower	19 24	4N 4N	8W 9W	SB SB	Grandview (Deadman) Canyon, north base of San Gabriel Mts., about 24 airline miles southeast of Palmdale. (Herein.)
161	Baughman deposit	Will Baughman et al., 141 W. Ave. 30, Los Angeles 31	7,18	3N	14W	SB	North side of Pacoima Canyon, about 6 airline miles north-miles northeast of San Fernando. Belt of white crystalline dolomite about 1,000 ft. long and 100 ft. wide dips steeply northward. Explored by shallow open cuts in 1920's. No production. Idle. (Logan 47:250; Oakeshott 37:244; Sampson 37:202; Tucker 27:322.)
162	Big Pine (Little Johnnie, Eagle)	Big Pine Mining Co., R.E. Shonerd, pres., 10909 Kenwood St., Inglewood (1930)	1 36 6	3N 4N 3N	8W 8W 7W	SB SB SB	North side of Table Mt., about 2 airline miles east of Swarthout (Big Pine). Partly in San Bernardino County. White limestone lens about 200 ft. thick, over a mile long, dips 45° southwestward in granitic gneiss. Explored by shallow surface trenching. No production. Idle. (Logan 47:281; Tucker 30:308; 31:383.)
	Eagle						See Big Pine.
163	Goodan deposit	Goodan Co., Roger Goodan, pres., 2550 Aberdeen, Los Angeles (1951)	28	3N	14W	SB	South side of Limerock Canyon, about 6 miles northeast of San Fernando. Bodies of dolomitic limestone associated with graphitic schist in San Gabriel metamorphic complex. Small tonnage produced and crushed for poultry grits 1945-1947; idle since 1947. See American Graphite Co. in graphite section.
164	Haskins	Mrs. Tessie Cook Haskins, 268 Burlington Ave., Los Angeles (1951)	28	3N	14W	SB	Limerock Canyon, about 4 airline miles north of Sunland. Discontinuous belt of white crystalline dolomitic limestone lenses 30-40 ft. thick, 100-200 ft. long. Bodies dip nearly vertically in meta-sediments and gneissoid granitic rocks of the San Gabriel complex. Worked by open cuts. Active 1880-1885 when lime was burned in 3

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
164	Haskins (cont'd)						kilns on property. Production about 5,000 tons in 1921-1924, intermittent subsequently. Idle since 1948. (See Lap Wing in gold section) (Logan 47:250; Oakeshott 37:244; Sampson 37:202-203.)
165	Hilltop	Frank A. Neher (1936)	21, 28	3N	14W	SB	North side of Limerock Canyon, about 6 miles northeast of San Fernando. Bodies of light-colored dolomitic limestone in metamorphic rocks of San Gabriel complex. Developed by open cuts in 1940's. Production small but undetermined. Idle.
166	Hilltop quarry	Undetermined	12	5S	14W	SB proj.	Palos Verdes Hills, about 3 miles south of Harbor City. Calcareous material from Lomita marl formation quarried for soil dressing and lime for poultry. Idle. (Woodring 46:120.)
167	Lincoln Service Corp.	Hewitt R. Taylor, 5853 Troost Ave., North Hollywood (1930)	27	3N	14W	SB	East side of Little Tujunga Canyon, about 6 airline miles east of San Fernando (Independent American Mica claims). Dolomitic limestone at contact with granitic rock mined for poultry grits and roofing granules. Several hundred tons produced 1924-1930. Idle.
	Little Johnnie						See Big Pine.
168	Lomita quarry (Palos Verdes deposit, Torrance Lime & Fertilizer Co.)	Torrance Lime and Fertilizer Co., Frank Samons, pres., Torrance (1927)	34	4S	14W	SB proj.	East slope of Palos Verdes Hills, about 1 mile southwest of Lomita. Fossiliferous Pleistocene marl and limestone beds 30 ft. thick dip 30° northwestward under 12 ft. of overburden. Nodules of phosphorite present in marl. Mined 1927-1929 from open pit 300 ft. long, 200 ft. wide, 60 ft. high, with dragline scraper. Crushed in 100-ton plant on property for use as soil conditioner and fertilizer. Total production undetermined. Idle. (Logan 47:249; Sampson 37:206; Tucker 27:328; Woodring 46:120.)

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Palos Verdes deposit						See Lomita quarry. (Logan 47:249.)
169	Ramelli (White Crystal)	Leo I. Gordon, 6742½ Kraft Ave., North Hollywood (1943)	16,17	3N	14W	SB	West side of head of Little Tujunga Canyon, about 6 miles northeast of San Fernando. Belt of white crystalline dolomitic limestone about 50 ft. wide and 300 ft. long dips moderately northward in granitic rock. Small tonnage mined in 1942 for poultry grit. Idle. (Logan 47:250; Newman 23a:165; Oakeshott 37:244; Sampson 37:203; Tucker 27:322.)
170	San Fernando deposit	Henry P. Dixon, 3475 East Randolph St., Huntington Park	19	3N	14W	SB	Limekiln Canyon, about 4 miles northeast of San Fernando. Body of white crystalline dolomitic limestone several hundred ft. wide and several thousand ft. long dips northward in granitic rock. Active to undetermined extent in 1800's; lime burned nearby. Long idle. (Logan 47:250; Oakeshott 37:244; Sampson 37:203; Tucker 27:322.)
171	Santa Ynez deposit	Los Angeles Mountain Park Co., Los Angeles. Leased jointly to Santa Monica Rock Co., A.H. Braun, pres., 17201 Sunset Blvd., Pacific Palisades and Flickinger & Welker, contractors, 2719 W. Vernon, Los Angeles (1953)	16	1S	16W	SB proj.	East side Santa Ynez Canyon, 3½ airline miles northeast of Topanga Beach. (Hoots 31:92, 133-134; Logan 47:248-249; herein.)
	Torrance Lime & Fertilizer Co.						See Lomita quarry. (Sampson 37:206.)
	Turner deposit	Dr. J.S. Turner (1919)	Approx.	3N	15W	SB	Pacoima Canyon, about 3½ miles northeast of San Fernando. Crystalline limestone of variable purity, in granitic

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Turner deposit (cont'd)						rock. Production undetermined. No activity reported since 1872. (Goodyear 88:340-341; Merrill 19:487.)
	White Crystal						See Ramelli.
	Wilson deposit	Mr. Wilson (1888)	Approx	3N	15W	SB	San Gabriel Mts., about 2 miles northwest of Pacoima Canyon. Crystalline limestone body in mica schist and gneissoid rocks. No lime produced for many years prior to 1919. Idle. (Goodyear 88:342; Merrill 19:487.)
172	Wragg Ranch deposit	George A. Mitchell, Glendale. Operated by Leo I. Gordon, 6742½ Kraft Ave., North Hollywood (1941)	18	3N	14W	SB	Pacoima Canyon, about 6 miles northeast of San Fernando. Slide boulders of white dolomitic limestone crushed for poultry grits. Yielded 400 tons 1940-1941. Idle since.

MICA

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
173	Apex	A.E. Allen, 3818 Tweedy Blvd., South Gate (1951)	29	4N	13W	SB	Ridge north of Pacoima Canyon, about 13 airline miles northeast of San Fernando. Muscovite in granite pegmatite. Explored by small open cut. One-half ton removed for testing in 1939. No commercial production. Idle. (Gordon, Leo I. personal communication 1951.)
174	Dorothy Ann	C.P. Brooks, 123 E. 82nd St., Los Angeles (1941)	30,31	4N	13W	SB	Ridge north of Pacoima Canyon, about 12 airline miles northeast of San Fernando. Muscovite in granite pegmatite. Explored by small open cut. Production undetermined but small. Idle.
175	Independent American Mining Co.	Frank X. Neher and C. W. Byrer, Los Angeles. Leased to Independent American Mining Co., 120 E. 8th St., Los Angeles (1937)	27	3N	14W	SB	East side of Little Tujunga Canyon, about 6 airline miles east of San Fernando. Mica schist in shear zone in granitic rock. Two tons produced and milled on property to 40-80 mesh size for use in paint prior to 1937; idle since. (Sampson 37:199.)
176	Mica 1	V.E. Clarke Enterprises	30,31	4N	13W	SB	Ridge north of Pacoima Canyon, about 12 airline miles northeast of San Fernando. Muscovite in granite pegmatite. Explored by small open cut. No production. Idle.
	Nora-Evalyn group	Robert Elliott, 3430 Montrose Ave., and E.O. King, 3337 Honolulu Ave., La Crescenta (1937)	19(?)	4N	14W	SB	Ridge south of Soledad Canyon, about 8 miles west of Acton. Occasional segregations of vermiculite associated with quartz-diorite dikes in anorthosite. No production. Idle. (Sampson 37:199-200.)
	Sunshine Mica Co. Mill	Sunshine Mica Co., John K. Bice, Walter Tocco, et al., 440 Seaton St., Los Angeles. Mill located 12234 Los Nietos Rd., South Whittier.					Mill for grinding mica, both wet and dry processes. Capacity 20-30 tons per day of all types of ground mica for use in paint, plastic, filler, rubber industries. Operating since April 1953. Raw materials from out-of-county sources.

MINERAL PAINT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Graphite deposits						Graphite from several localities has been used for paint pigment. See graphite section for property descriptions.
	Paradise deposit	Paradise Borax Mining Co., O.C. Gray, pres., San Fernando (1919)	27	4N	15W	SB	South side Santa Clara River valley, about $1\frac{1}{2}$ miles south of Humphreys. Clay containing 9-15% boric acid. Mined about 1919 for use in kalsomine paint. Production undetermined. Long idle. (Merrill 19:481,507.)
	Redondo deposit	Undetermined	Approx	3S	15W	SB	Coast bluffs, 2-3 miles north of Redondo Beach. Fine, pure clays of yellow, brown ochre tints. Tested for paint use prior to 1890. Production undetermined. Long idle. (Aubury 06:338; Merrill 19:507; Preston 90a:208; Symons 30:154.)
	Santa Catalina Island deposit	Santa Catalina Island Co., Avalon	10(?)	10S	14W	SB proj.	Renton Canyon, about 2 airline miles southeast of Avalon. Red and yellow ochre in oxidized outcrops of lead-silver-zinc veins of Renton Vein mine. One vein of red ochre 6-18 in. wide tested for use in paint in 1927. No production. Idle. (Sampson 37:206; Symons 30:154; Tucker 27:38, 329

ROCK PRODUCTS - BROKEN AND CRUSHED STONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
177	Acton Rock Co.	Acton Rock Co. (Los Angeles Stone Co., 1316 Baker-Detwilder Bldg., Los Angeles) (1919)	2	4N	13W	SB	East base of Parker Mt., about $\frac{1}{2}$ mile west of Acton. Excavation about 200 ft. by 250 ft. by 70 ft. deep in dioritic rock. Provided crushed rock primarily for railroad ballast in early 1900's. Long inactive (Merrill 19:486.)
	Breslin greenstone quarry	Gene Breslin, Little Rock (1927)	19	5N	11W	SB	North flank of San Gabriel Mts., about $2\frac{1}{4}$ airline miles east of Vincent, about 6 airline miles southeast of Palmdale. Green Tertiary Escondido (Vasquez) basalt ("diabase") quarried by 3 employees; ground to coarse sand for roofing material in Los Angeles (1927). Inactive since before 1931. Idle. (Simpson 34:411; Tucker 27:332.)
	Brush Canyon quarry	Los Angeles Stone Co., 1316 Baker-Detwilder Bldg., Los Angeles (1919). Union Rock Co. George A. Rogers, pres. (1921-1927).	35(?) or 2(?)	1N 1S	14W 14W	SB SB	East slope of Brush Canyon, about 2 miles northeast of Hollywood. Fine-grained crystalline rock quarried from excavation 200 ft. by 700 ft. by 150 ft. deep. Power shovel loaded railroad cars for transport to plant for crushing and screening. Crushed stone produced for concrete aggregate. Capacity about 1000 tons per day (1919); 16 employees (1927). Long idle. (Merrill 19:486; Tucker 21:322; 27:341-342.)
178	Connolly-Pacific (Pebbly Beach) quarry		11(?)	10S	14W	SB proj.	Santa Catalina Island, Jewfish Pt., about 2 miles southeast of Avalon. (Plate 5 herein.)
	Devil's Gate	Los Angeles and Salt Lake Railroad (1906)	7(?)	1N	12W	SB proj.	Devil's Gate, northwestern Pasadena. Granitic rock quarried and crushed for railroad ballast (1906). Inactive. (Aubury 06:28.)
179	Empire (Graham Brothers) quarry		29(?)	8S	15W	SB proj.	Santa Catalina Island coast, about $1\frac{1}{2}$ miles northwest of Empire Landing. (Lenhart 50a:184-186; Tucker 27:39; plate 5 herein.)
	Graham Brothers						See Empire and Pebbly Beach quarries.

ROCK PRODUCTS - BROKEN AND CRUSHED STONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Haines Canyon	Haines Canyon Rock Co. Peter Perry, pres., 5200 San Fernando Rd., Glendale (1927)	17(?)	2N	13W	SB	Haines Canyon, several miles east of Sunland. Screening and crushing plant (1927). Inactive. (Tucker 27:338.)
180	Hansen Dam quarry	Operated by Guy F. Atkinson Construction Co. 22233 S. Santa Fe Ave., Long Beach	27	3N	14W	SB	South side of Gold Creek, about 3/4 mile east of Little Tujunga Canyon, about 6 airline miles northeast of San Fernando. Area about 1/4 mile by 1/2 mile quarried to provide about 770,000 tons of granitic rock for facing, toe filling, and crib-rock for Hansen Flood-Control Dam, 1938-1940. Idle.
181	Livingston Rock & Gravel Co.		9,16	5S	14W	SB proj.	Southwest slope of Palos Verdes Hills, overlooking Portuguese Bend, about $4\frac{1}{2}$ miles northwest of Pt. Fermin. (Rock Products 49a:68-69,85; plate 5 herein.)
182	Los Angeles City quarry	Santa Catalina Island Co., Avalon. Leased to City of Los Angeles, Office of the Harbor Engineer	29(?)	8S	15W	SB proj.	Santa Catalina Island, about 2 miles northwest of Empire Landing, adjacent to Graham Bros. Empire quarry. Operated intermittently from about 1920 to 1940 to provide riprap and facing for harbor projects. Stone as large as several tons, excavated with power shovels from face 500 ft. long, hauled by rail to barges for transport to mainland. Capacity about 400 tons per day. Idle since 1940.
	Los Angeles County quarry						See San Dimas Rock Co. (Merrill 19:486.)
	Los Angeles Stone Co.						See Acton Rock Co. and Brush Canyon quarry. (Merrill 19:486.)
	Nickel greenstone quarry	R.E. Nickel, Acton (1927). Leased to R.C. Sides, Hollywood	21,28	5N	11W	SB	North flank of San Gabriel Mts., about $4\frac{1}{2}$ airline miles east of Vincent and about 1 mile northwest of Little Rock Reservoir. Green Tertiary Escondido basalt "diabase" exposure 500 ft. by 1000 ft. mined in 4 places. Crushed and screened in plant with 25 tons per day capacity, op-

ROCK PRODUCTS - BROKEN AND CRUSHED STONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Nickel greenstone quarry (cont'd)						erated by 3 men. Several sizes of crushed stone, about sand size, produced for roofing materials. Idle. (Simpson 34:411; Tucker 27:322.)
183	Pebbly Beach (Santa Catalina Island) quarry	Santa Catalina Island Co., Avalon. Output handled by Graham Bros. 5500 N. Peck Rd., El Monte (1927)	2(?)	10S	14W	SB proj.	Santa Catalina Island about 1 mile southeast of Avalon. Andesitic rock quarried with steam shovels, hauled by rail to crushers, barged to mainland. Capacity 1,000 tons per day; 100 employees in 1927. (Tucker 27:38-39, 337.)
	Pebbly Beach quarry						See Connolly-Pacific.
	San Dimas Rock Co. (Los Angeles County quarry)	San Dimas Rock Co. (prior to 1919)	Approx.	1N	9W	SB	San Dimas. Rock plant acquired by L.A. County prior to 1919 for employment of prisoners. (Merrill 19:486.)
	Santa Catalina Island quarry						See Pebbly Beach (Santa Catalina Island) quarry.
	Union Rock Co.						See Brush Canyon quarry. (Tucker 21:322; 27:341-342.)
	West Slope Construction Co.	West Slope Construction Co., Azusa (1936)					Location undetermined. More than 7 million yards of granitic rock produced about 1936 in sizes up to 2 tons for use in the San Gabriel Dam project. No commercial production. Long idle. (Sampson, R.J., unpublished report, 1937.)

ROCK PRODUCTS-CRUSHED STONE (DECOMPOSED GRANITE)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
184	L.A. Decomposed Granite Co.	L.A. Decomposed Granite Co., Box 39, Montebello (1953)	2	2S	12W	SB proj.	Montebello Hills, north of Lincoln Ave., between Maple and Cedar Aves. (Plate 5 herein.)
185	McCaslin Materials Co.	McCaslin Materials Co. 450 Potrero Grande Dr. Monterey Park (1953)	35	1S	12W	SB proj.	Montebello Hills, just northwest of Potrero Grande Dr., about 1 mile northeast of Garfield Ave.-3d St. corner. Plate 5 herein.)
186	Monterey Park Granite Co.	Monterey Park Granite Co. Inc., 1310 S. Garfield Ave., Monterey Park (1953)	27,34	1S	12W	SB proj.	Montebello Hills, just east of Garfield Ave., about 1 mile north of 3d St. (Plate 5 herein.)
187	Mulholland DG Co.	Mulholland DG Co., 5032 Lankershim Blvd., North Hollywood	35	1N	16W	SB proj.	Santa Monica Mts., just south of Mulholland Drive, about 1/4 mile east of a line extended due south of Reseda Blvd. (Plate 5 herein.)
188	Owl Rock Products Co.	Owl Rock Products Co., P.O. Box 187, Monrovia	36	1S	12W	SB proj.	Montebello Hills, just south of Arroyo Drive, about 3/4 mile northwest of San Gabriel Blvd. No data released for publication.
189	Reynolds Crushed Gravel Co.	Reynolds Crushed Gravel Co., 914 N. Humphrey, Los Angeles (1952)	30,31	1S	12W	SB	Repetto Hills, north end of Cordova Ave. (N. Humphreys), about 1/4 mile southwest of L.A. Co. Sheriff's pistol range. Poorly sorted, unconsolidated sandy conglomerate of Pleistocene La Habra formation (?) strikes west, dips 40-60° S. Granitic rock types, largely decomposed. Pit 800 ft. long, 150 ft. wide, 50 ft. deep mined with 1-yd. diesel shovel, hauled by trucks, reduced in jaw crusher. After many years activity became inactive in 1952 because of excessive clay content.

ROCK PRODUCTS-DIMENSION STONE (GNEISS)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Lordsburg deposit	Undetermined	26	1N	9W	SB	South flank of San Gabriel Mts., about 4 miles east of Glendora. Red, fine-grained eruptive rock bordered by red gneiss quarried for building stone (1890). Idle. (Preston 90a:209.)

ROCK PRODUCTS - DIMENSION STONE (GRANITE)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Ross deposit	E.M. Ross, Glendale (1906)	Approx	1N	13W	SB proj.	Glendale Ranch, Verdugo Canyon, 8 miles from Los Angeles, 3/4 mile from the railroad. Banded dark hornblende biotite granite reported suitable for monuments and trim. Undeveloped. (Aubury 06:28; Merrill 19:481; Tucker 27:330.)

ROCK PRODUCTS - DIMENSION STONE (SANDSTONE)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	California Construction Co.						See Chatsworth Park quarry. (Aubury 06:128; Merrill 19:483.)
	Charlton quarry	O.A. Charlton	7	2N	16W	SB proj.	Sugar Loaf Hill (?), near lower Aliso Canyon, about 2 miles northwest of Granada. Cretaceous sandstone quarried (1906). Idle. (Aubury 06:130.)
190	Chatsworth Park quarry	California Construction Co., 324 E. Market St. Los Angeles (1906)	13	2N	17W	SB	East side of Chatsworth Peak, $1\frac{1}{2}$ miles west of Chatsworth. Arkosic Upper Cretaceous sandstone, fine-grained and heavily bedded, blue-gray when fresh, tawny on weathered surfaces. Churn drilled with 25-ft. holes, blasted, removed with steam derricks; railroad spur to quarry. Produced building stone, riprap, and San Pedro breakwater. Quarry abandoned several years prior to 1919; inactive since. (Aubury 06:128, 130; Merrill 19:482-483, Tucker 27:330.)
191	Clement quarry	H. Clement & Co.	13	2N	17W	SB	Chatsworth Park, $1\frac{1}{2}$ miles west of Chatsworth, western part of California Construction Co. quarry. Dimension stone produced using plugs and feathers (1906). Stone similar to that of California Construction Co. Long idle. (Aubury 06:131.)
	Gilbert	Mr. Gilbert (1888)	Approx.	2N	17W	SB	Vicinity of Chatsworth (?), about 12 miles west of San Fernando. Medium-grained, light-colored, yellowish sandstone of uniform texture but soft. Building stone produced (1888). Idle. (Goodyear 88:341.)
192	Santa Ynez Canyon quarry	Los Angeles Mountain Park Co., Los Angeles. Leased to Santa Monica Rock Co., A.H. Braun, pres., 17201 Sunset Blvd., Pacific Palisades, and Flickinger &	21	1S	16W	SB	Santa Ynez Canyon, about 2 airline miles north of Coast Highway. Massive gray Cretaceous-Eocene sandstone derived from granitic source. Quarry face 250 ft. high, 550 ft. long. Intermittent production since 1930's for building stone, waterfront construction. Secondary blasting, splitting by hand methods.

ROCK PRODUCTS - DIMENSION STONE (SANDSTONE, LIMESTONE, SCHIST)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
192	Santa Ynez Canyon quarry (cont'd)	Welker, contractors, 2719 W. Vernon, Los Angeles (1953)					
193	Southern Pacific quarry	Southern Pacific Railroad Co. Leased to C. Bertelson, 1307 W. Ninth St., Los Angeles	12	2N	17W	SB	East side of Santa Susana Pass, about $1\frac{1}{2}$ miles northwest of Chatsworth, near east end of middle railroad tunnel. Cretaceous sandstone similar to that of nearby Chatsworth Peak quarry produced for use as dimension stone. Hand drilled, blasted, split with wedges, handled by horsepower. Twenty-five tons per day produced by 9 men (1906). Idle. (Aubury 06:131.)
	Santa Ynez deposit						See in limestone section. (Hoots 31:92, 133-134; Logan 47:248-249; herein.)
194	Blue Goose	Robert and Mary Cox, 1975 Lundy Ave., Pasadena (1953)	11	5N	16W	SB	San Francisquito Canyon, about 1/4 mile southwest of Power House No. 2. Fissile silver-gray Pelona schist produced from quarry face 100 ft. high, 100 ft. wide. Intermittent production of flagstone and wall rock since about 1924 by various lessees. Total production about 100 tons.
195	Bouquet Canyon quarry (Pyle)	A.J. Pyle, General Delivery, Newhall (1952)	15	5N	15W	SB	Bouquet Canyon, about 11 miles northeast of Saugus, elevation 1950 ft. Gray micaceous Pelona schist quarried in slabs for driveway sets and stepping stones. Six men employed in 1927. One man active in 1952. (Tucker 27:331.)
196	Deem	Charles M. Deem, Box 332, Rt. 2, Saugus (1953)	34	6N	15W	SB proj.	South slope of juncture of Bee and San Francisquito Canyons, about $11\frac{1}{2}$ airline miles north of Saugus. Fractured gray Pelona schist quarried by hand methods from face 100 ft. long, 40 ft. high. Several hundred tons total production in intermittent operations since quarry opened in late 1940's.

ROCK PRODUCTS - DIMENSION STONE (SCHIST)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
197	Desert Stone quarry No. 1 (Jones)	H.A. Jones, 215 W. Green St., Pasadena (1953)	10,15	5N	15W	SB	Bouquet Canyon, about 9½ airline miles northeast of Saugus. Chloritic gray Pelona schist quarried from face about 75 ft. high and 180 ft. long. Stone broken by hand after blasting face. Flagstone and building stone produced since about 1923. Two employees in 1952. (Tucker 27:332.)
198	Golden Rock	L.H. Barber, V.B. Williams, 1234 Foothill Blvd., La Canada (1953)	3	5N	15W	SB	Del Sur Ridge, between Bouquet and San Francisquito Canyons, about 11½ airline miles northeast of Saugus. Flat-lying micaceous Pelona schist exposed in shallow pit about 100 yards square. Production undetermined but small. Intermittently active in 1952.
199	Hoffman	Samuel L. Hoffman, 417 S. Boyle Ave., Los Angeles (1952)	35	6N	15W	SB proj.	Del Sur Ridge, between Bouquet and San Francisquito Canyons, about 12 airline miles northeast of Saugus. Gray Pelona schist exposed in shallow workings. Production undetermined but small. Idle in 1952.
	Jones						See Desert Stone quarry No. 1. (Tucker 27:332.)
200	Perry	Roger C. Perry, 195 N. Oakland Ave., Pasadena (1952)	3	5N	15W	SB	Del Sur Ridge, between Bouquet and San Francisquito Canyons, about 10½ airline miles northeast of Saugus. Pelona schist exposed in shallow workings. Production undetermined but small. Idle in 1952.
201	Poteet	Don Poteet, 630 Flower Ave., Venice (1953)	3	5N	15W	SB	Del Sur Ridge, between Bouquet and San Francisquito Canyons, about 11-3/4 airline miles northeast of Saugus. Flat-lying, fissile, blue-gray Pelona schist exposed in area about 100 yards square by bulldozer, hand work. Production undetermined but small. Intermittently active in 1952.
	Pyle						See Bouquet Canyon quarry.

ROCK PRODUCTS - DIMENSION STONE (SCHIST, Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
202	Raggio's Franciscan & Silver Sheen quarries	Frank P. Raggio, Rt. 2, Box 353, Saugus (1953)	11	5N	16W	SB	San Francisquito Canyon, about 1/4 airline mile north of Power House No. 2, about $8\frac{1}{2}$ airline miles north of Saugus. Gray Pelona schist removed from 2 quarries about 50 ft. square, 100 yards apart across San Francisquito Creek. Several hundred tons of flagstone and building stone produced in intermittent operations since 1924.
203	Switzer No. 1	L. Glen Switzer, 3464 E. Foothill Blvd., Pasadena (1952)	3	5N	15W	SB	Del Sur Ridge, between Bouquet and San Francisquito Canyons, about $11\frac{1}{2}$ airline miles northeast of Saugus. Flat-lying, fissile Pelona schist exposed in shallow workings about 100 ft. by 200 ft. Production undetermined but small. Active in 1952.
204	Switzer No. 2	L. Glen Switzer	2	5N	15W	SB	West side of Bouquet Canyon, about $11\frac{1}{2}$ airline miles northeast of Saugus. Weathered Pelona schist quarried from workings scattered over several acres. Production undetermined but small. Idle in 1952.

ROCK PRODUCTS - DIMENSION STONE (SERPENTINE)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
205	Banning (Empire Landing) quarry	Santa Catalina Island Co., Avalon (1953)	4(?)	9S	15W	SB proj.	Santa Catalina Island, about 1 mile south of Empire Landing, about 9 airline miles northwest of Avalon. Fibrous green serpentine rock bearing tremolite-actinolite in part altered to talc, suitable for polishing. Quarry yields both hard and soft commercial stone. The soft material was sawed into slabs 1-inch thick but the hard material was worked with stonecutter's tools. Used for ornamental, sanitary, and electrical purposes. Eighty employees reported in 1896. Inactive since 1913. (Aubury 06:147; Crawford 94:402; 96:639; Merrill 19:483; Preston 90b:280; Tucker 27:331.)

ROCK PRODUCTS - DIMENSION STONE ("TRACHYTE")

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lang Quarry	Santa Catalina Island Co., Avalon (1953)	3(?)	9S	15W	SB proj.	Santa Catalina Island, northeast coast, near Empire Landing. Bluffs of "trachytic rock" suitable for building stone but most used for railroad construction and San Pedro Harbor projects. Quarry active about 1880-1895; 150,000 tons removed. Difficulty of obtaining large blocks curtailed operations. (Aubury 06:154-155; Crawford 96:404; Merrill 19:484; Preston 90b:279; Tucker 27:332.)

ROCK PRODUCTS - MISCELLANEOUS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
206	Blue Cloud chinchilla dust	Blue Cloud Mineral Co., W.C. Harris, pres., 519 8th St., Newhall (1953)	32	5N	15W	SB	Bouquet Canyon, about 1/4 mile west of highway, about 5 airline miles northeast of Saugus. (Herein.)
207	Katz diatomaceous shale	Dr. Leon Katz, 9837 Foothill Blvd., San Fernando (1953)	10	2N	14W	SB proj.	Schwartz Canyon, north side of Tujunga Valley, about 1/4 mile north of Foothill Blvd., about 2 airline miles northwest of central Sunland. (Herein.)
	Redondo Beach chalcedony	Undetermined		3,4S	14, 15W	SB proj.	Pacific Ocean beach from Redondo to Playa del Rey. Wave-washed pebbles of chalcedony and agate collected at low tide. (Merrill 19:500.)
208	Reynier Ranch volcanic ash	Reynier Ranch Estate, operated by Frank E. Walker & Sons, Box 277 Newhall (1940)	35	4N	15W	SB	West side of Sand Canyon, opposite Iron Canyon, about 6 miles east of Newhall. (Herein.)
	San Antonio Canyon corundum	Undetermined	24(?)	1N	8W	SB	San Antonio Canyon, about 5 miles above Uplands. Syenite (?) containing small crystals of ruby corundum, possibly useful for abrasive. Undeveloped. Long inactive. (Merrill 19:480.)
	Santa Catalina Island "moonstones"	Santa Catalina Island Co., Avalon (1953)	17(?)	9S	14W	SB	Santa Catalina Island, Moonstone Beach, about 8 miles northwest of Avalon. Quartz nodules weathered out of rhyolite rock collected on beach as "moonstones". Supply exhausted by 1919. (Merrill 19:500.)
209	Sheba Fertilizer deposit	Eugene Graves, 4358 Elizabeth St., Bell (1937)	14	5N	12W	SB	North side of Soledad Pass, about $1\frac{1}{4}$ airline miles northeast of Vincent, about $\frac{1}{4}$ mile from Highway 6. Shattered zone in altered basalt and diabase, impregnated with carbonate minerals and traces of gypsum reported valuable for fertilizer (1937). Outcrops explored for 150 yds. by 100-ft. adit (inaccessible in 1953), and several small

ROCK PRODUCTS - MISCELLANEOUS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
209	Sheba Fertilizer deposit (cont'd)						open cuts. Production undetermined; mill foundations abandoned. Long inactive. (Sampson 37:213.)
	Stewart jasper deposit	J. Stewart, 1417 E. 21st St., Los Angeles (1906)	28	5N	12W	SB	Soledad Canyon about 3 miles northeast of Acton, on the Southern Pacific railroad. Jasper crowns ridge 25-30 ft. high, 30-40 ft. wide, 1/4 mile long. Red, blue, and mottled jasper susceptible to fine polish suitable for ornamental building purposes. Only surface rock removed (1906). Production, development undetermined. Idle. (Aubury 06:305.)
	"Volcanic rock"	Undetermined	18	1N	17W	SB	Las Virgenes Canyon, about $1\frac{1}{2}$ miles north of Brents Junction, Ventura Blvd. Upper Miocene Modelo shale, naturally burned to bright red and variegated colors. Resembles fused lava, hard and brittle. Quarried and solf for ornamental use under trade name "volcanic rock". Production, activity undetermined. (Soper 38:180.)

ROCK PRODUCTS - SAND AND GRAVEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
210	Arrow Rock Co. - Duarte plant		36	1N	11W	SB proj.	San Gabriel Wash, about 4 miles west of Azusa.(Plate 5 herein.)
211	Arrow Rock Co. - Sun Valley plant (Mahan)		19,30	2N	14W	SB proj.	Tujunga Wash, east corner of Wicks St. and San Fernando Rd., about 1½ miles south of Hansen Dam. (Rock Products 49b:96-97; plate 5 herein.)
212	Azusa Rock & Sand Co. (Woods)		3,4 33,34	1S 1N	10W 10W	SB SB proj.	San Gabriel Wash, Mira Loma at Paramount St., about 1 mile southwest of Azusa. (Plate 5 herein.)
	Baldwin Construction Co.	Baldwin Construction Co. (1919)					Pasadena; crusher near Lester Ave. and Arroyo Seco. Long idle. (Merrill 19:485.)
	Baldwin Park plant						See under Consolidated Rock Products Co.
213	Richard R. Ball		28	4S	14W	SB proj.	Northeast side of Palos Verdes Hills, south end of Hawthorne Blvd., south edge of Walteria. (Woodring 46:120; plate 5 herein.)
214	Beyrle	Robert Beyrle, 462 Ave. 20, Los Angeles (1919)	15	1S	13W	SB proj.	Arroyo Seco and N. Ave. 20, Los Angeles. Crusher operated prior to 1919. (Merrill 19:485.)
	Big Tujunga						See under Consumers Rock & Gravel Co. (Tucker 27:335.)
	Bixley	H.O. Richwine, Gardena (1919)					Bixley; gravel pit yielding small tonnage for local use in concrete. Long idle. (Merrill 19:486.)
215	Blue Diamond - Alameda pit	Blue Diamond Corp., 1650 S. Alameda St., Los Angeles P.O. Box 2678, Terminal Annex, Los Angeles 54	3	2S	13W	SB proj.	Los Angeles, between 16th and Washington Sts. east of Alameda St. Sand and gravel produced from pit 700 ft. by 1100 ft. by 75 ft. deep (in 1925). Active 1916 (?) to 1932; being filled in 1953.

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
216	Blue Diamond - Peck Rd. pit	Blue Diamond Corp.	2	1S	11W	SB proj.	San Gabriel (Rio Hondo) Wash, southwest corner Peck Rd. at Arrow Hwy. about 6 miles southwest of Azusa. Active from 1936 or 1937 to 1948.
217	Blue Diamond - Pierson plant	Blue Diamond Corp.	2	1S	11W	SB proj.	San Gabriel (Rio Hondo) Wash, pits both north and south of Arrow Hwy. just east of Peck Rd. about 6 miles southwest of Azusa. Sand, gravel and crushed rock produced in plant north of Arrow Hwy. Two pits about 500 ft. by 700 ft. by 50 ft. deep (north pit) and 600 ft. by 900 ft. by 50 ft. deep (south pit) active 1932 to 1937.
218	Blue Diamond - Roscoe plant (Penrose plant of Consumers Rock & Gravel Co.)	Blue Diamond Corp.	31,32	2N	14W	SB proj.	Tujunga Wash, northeast corner of Strathern St. at Tujunga Ave., about 2-3/4 miles south of Hansen Dam. (Plate 5 herein.)
219	Blue Diamond - Santa Fe plant	Blue Diamond Corp.	1	1S	11W	SB proj.	San Gabriel Wash, north side of Arrow Hwy. about $\frac{1}{2}$ mile west of Santa Fe Dam. (Plate 5 herein.)
	Boulevard plant						See under Union Rock Co. (Tucker 27:340.)
	Builders	Builders Crushed Rock Products Co., E.C. Hotchkiss, pres., Azusa (1927)					See Livingston. (Tucker 27:334.)
220	California Materials Co. (John D. Gregg)		19,20, 29,30	2N	14W	SB proj.	Tujunga Wash, west corner of Glenoaks Blvd. and Pendleton St., about $1\frac{1}{2}$ miles south of Hansen Dam. (Plate 5 herein.)
	California Rock & Gravel Co.	California Rock & Gravel Co. (1919)					Arroyo Seco; crusher at Lester Ave. and Arroyo Seco, Pasadena. Long idle. (Merrill 19:485.)
221	Chandlers Palos Verdes, sand and Gravel Co.		35	4S	14W	SB proj.	Northeast side of Palos Verdes Hills, on Narbonne Ave. just south of Lomita. (Plate 5 herein.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
222	City of L.A.	City of Los Angeles (1919)	15	1S	13W	SB	Arroyo Seco and N. Ave. 19, Los Angeles. Small crushing plant operated by City of Los Angeles for street repairs. Long inactive. (Merrill 19:485.)
223	City Rock Co.		9,10	2N	14W	SB proj.	Tujunga Wash at Cottonwood, about 1/2 mile west of Foothill Blvd. causeway. (Plate 5 herein.)
	Coast Rock & Gravel Co.						See Consolidated Rock Products Co. - Reliance plant. (Tucker 27:339-340.)
224	Concrete Materials Co.	Concrete Materials Co., H.W. Jones, pres. (1927)	5	1N	14W	SB proj.	East side Tujunga Wash, northeast corner Sherman Way and Tujunga Ave., about 4 miles south of Hansen Dam. Ten-acre holding, 30% rock and 70% sand, operated with drag-line scraper. Crushing and screening plant capacity 60 tons per hour; 8 employees in 1927. (Tucker 27:334.)
	<u>Consolidated Rock Products Co.</u> (Consumers Rock & Gravel Co., Union Rock Co.)	Consolidated Rock Products Co., 2730 So. Alameda St., Los Angeles 58, P.O. Box 2950 Terminal Annex, Los Angeles 54					Consumers Rock & Gravel Co. and Union Rock Co., with extensive holdings in San Gabriel and Tujunga Washes, merged in 1929 to form Consolidated Rock Products Co. Reorganization followed and additional holdings were acquired and released. Six plants were active in 1952, one (Irwindale No. 7) is described in specialty sands section.
225	Alameda St. plant	Consolidated Rock Products Co.	10	2S	13W	SB proj.	Los Angeles, 27th St. between Alameda St. and San Pedro Ave. Sand and gravel produced from pit 500 ft. by 1,000 by 70 ft. deep. Little or no crushing required. Active from prior to 1919 to 1946. (Merrill 19:486.)
226	Baldwin Park plant (Russell-Greene-Foell, Union Rock Co.)	Consolidated Rock Products Co.	8	1S	10W	SB proj.	East side of San Gabriel Wash, about 3/4 mile northeast of Baldwin Park and 1 mile southwest of Irwindale. Pit about 1,000 ft. by 2,500 ft. by 65 ft. deep, adjoining Irwindale No. 6 pit on west, excavated by steam shovels. Rail transport in pit to plant for crushing and screening. Capacity 500 tons per hour with 28 employees in 1927.

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
226	Baldwin Park plant (Russell-Greene-Foell, Union Rock Co.) (cont'd)						Shut down since 1932; bunkers used for storage for Irwindale specialty rock products plant in 1952. (Tucker 21: 322; 27:342-343.)
227	Durbin plant (Los Angeles Rock Co., Union Rock Co.)	Consolidated Rock Products Co.	13	1S	11W	SB proj.	San Gabriel Wash, about 1-3/4 miles west of Baldwin Park. U-shaped pit about 500 ft. wide by 5,000 ft. long. Plant capacity 300 tons per hour with 25 employees in 1927. Inactive since plant burned in 1931 except in 1951 when concrete sand was produced. (Tucker 27:343.)
228	Hewitt plant (Consumers Rock & Gravel Co.)	Consolidated Rock Products Co.	1	1N	15W	SB proj.	Tujunga Wash, northwest corner of Sherman Way and Laurel Canyon Blvd., about 4 miles south of Hansen Dam. (Tucker 27:335; plate 5 herein.)
229	Irwindale plant No. 6 (John D. Gregg)	Consolidated Rock Products Co.	8,9	1S	10W	SB proj.	East side San Gabriel Wash, south of Bonita Ave., between Azusa Canyon Rd. and Irwindale Ave., about 1/4 mile southwest of Irwindale. (Griffin 51:34-37; Rock Products 50: 101-103,145; plate 5 herein.)
230	Kincaid plant (Union Rock Co.)	Consolidated Rock Products Co.	33	1N	10W	SB proj.	East side San Gabriel Wash, east of Irwindale Ave., between Santa Fe R.R. tracks and Foothill Blvd., about 1 mile west of Azusa. Pit about 1/2 mile by 1,000 ft., 40-80 ft. deep; 75% coarse gravel and larger rocks. Excavated by steam shovel; rail haulage in pit to plant for crushing, screening, and washing. Capacity 300 tons per hour; 20 employees in 1927. Plant burned after 1929. Inactive except dam-facing cobbles produced 1951-1952. (Tucker 27:343-344.)
231	Largo plant (Pacific Rock & Gravel Co. Union Rock Co.)	Consolidated Rock Products Co.	28,33	1N	10W	SB proj.	East side San Gabriel Wash, northeast corner of Irwindale Ave. and Foothill Blvd., about 1 mile west of Azusa. (Merrill 19:484; Tucker 21:322;27:344; plate 3 herein.)
232	Penrose plant (Consumers Rock & Gravel Co.)						See under Blue Diamond-Roscoe plant. (Tucker 27:335-336.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
233	Reliance Plant (Coast Rock & Gravel Co., Reliance Rock Co.)	Consolidated Rock Products Co.	33	1N	10W	SB proj.	East side San Gabriel Wash, just west of Irwindale Ave., about 0.6 miles south of Foothill Blvd., $1\frac{1}{2}$ miles southwest of Azusa. Pit about 850 yards by 250 yards by 120 ft. max. depth; 75% coarse gravel and boulders. Excavated by steam shovels. Haulage by inclined tramway to plant for crushing, screening, and washing. Capacity 50 tons per hour in 1927. Inactive since 1930; plant dismantled 1951. (Tucker 27:339-340.)
234	Roscoe plant (Consumers Rock & Gravel Co., Los Angeles Stone Co., Tujunga Rock Co.)	Consolidated Rock Products Co.	18,19, 30	2N	14W	SB proj.	Tujunga Wash, north corner of San Fernando Rd. and Tuxford St.; holdings extend nearly 2 miles to Hansen Dam. (Merrill 19:485; Rock Products 49c:100; Tucker 21:322; 27:336; plate 5 herein.)
	Sheldon plant (Consumers Rock & Gravel Co.)	Consolidated Rock Products Co.	17	2N	14W	SB	East side Tujunga Wash, Sheldon St. at Stonehurst Ave. (Mulholland St.), about 1/2 mile south of Hansen Dam. Pit 2,000 ft. by 300 ft. by 50 ft. deep; 75% coarse sand and boulders. Excavated by $4\frac{1}{2}$-yards, steam shovel; hauled by rail to plant for crushing, screening, and washing. Capacity about 300 tons per hour; 30 employees in 1927. Long inactive. (Tucker 27:337.)
235	Sierra plant	Consolidated Rock Products Co.	2	1S	11W	SB proj.	West side San Gabriel Wash, about 0.4 miles east of Peck Rd.-Live Oak Ave. corner, about 0.2 miles south of Live Oak Ave. (Arrow Hwy.) (Plate 5 herein.)
	Consumers Rock & Gravel Co.	Consumers Rock & Gravel Co., Frank Gautier, pres., 2600 S. Alameda St., Los Angeles (1927)					Six plants in San Fernando Valley produced total of more than 1,000 tons per hour in 1927; one plant at 26th and Alameda Sts. Los Angeles. Merged into Consolidated Rock Products Co. in 1929. See Alameda St., Hewitt, Penrose, Roscoe, and Sheldon plants under Consolidated Rock Products Co. (Merrill 19:486; Tucker 27:334-337.)
236	Big Tujunga plant	Consumers Rock & Gravel Co. (1927)	19	2N	14W	SB proj.	Tujunga Wash at Wahoo Siding, north corner of San Fernando Rd. and Truesdale St., about 1 mile south of Hansen

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
236	Big Tujumga plant (cont'd)						Dam. Pit $1\frac{1}{2}$ miles north of plant. Material is 65% coarse gravel and boulders. Excavated by steam shovels; transported by rail to plant for crushing, screening, and washing. Capacity over 200 tons per hour; 30 employees in 1927. Long idle; plant dismantled. (Tucker 27:335.)
	National plant	Consumers Rock & Gravel Co. (1927)	32(?)	2N	14W	SB proj.	Tujunga Wash, "3 miles east of Hewitt plant on Strathern St., Lankershim". Plant capacity 50 tons per hour; 8 employees in 1927. Long idle. (Tucker 27:335.)
	Cooperative Building Materials Co.	Cooperative Building Materials Co., William Bell, pres. (1927)	Approx	2N	14W	SB proj.	Tujunga Wash "at Roscoe, 1/4 mile east of Penrose plant and $1\frac{1}{2}$ miles south of San Fernando Blvd." Deposit is 65% rock, 35% sand. Haulage to plant by dragline scraper. Capacity 50 tons per hour; 7 employees in 1927. Long inactive. (Tucker 27:334.)
	Ducey & Atwood						See Osborn.
	Durbin plant						See under Consolidated Rock Products Co. (Tucker 27:343.)
237	John M. Ferry Rock Products		2	5N	11W	SB	Antelope Valley, Little Rock Wash, just north of Pearblossom Hwy. (Ave. T.), 1.7 miles northwest of Little Rock. (Plate 5 herein.)
	Gordon-Garrison-Russell	Gordon-Garrison-Russell Inc., H.J. Kingsland, pres., 155 E. Jefferson St., Los Angeles (1927)	Approx	2N	13W	SB proj.	Verdugo Canyon, northeast of Montrose. Plant capacity 60 tons per hour; 10 employees in 1927. Idle. (Tucker 27:337.)
238	Graham Bros - El Monte plant		1	1S	11W	SB proj.	San Gabriel Wash, 3/4 mile east of Peck Rd. - Arrow Hwy. corner, 0.3 miles south of Arrow Hwy., $2\frac{1}{2}$ miles west of Irwindale. (Lenhart 50c:80-81,150-152; plate 5 herein.)
	Graham Bros.-Lomita plant	Graham Bros., Inc., R.	Approx	4S	14W	SB	East slope of Palos Verdes Hills, near Lomita. Twelve men

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Graham Bros.-Lomita plant (cont'd)	Graham, pres., 1512 W. 7th St., Los Angeles (1927)	Approx	4S	14W	SB proj.	employed operating a sand plant in 1927. Long idle. (Tucker 27:337.)
239	Graham Bros.-Roscoe plant	Graham Bros., Inc., 5500 N. Peck Rd., El Monte (1942)	30	2N	14W	SB proj.	Tujunga Wash, between Tujunga and Telfair Aves., southeast of Tuxford St., about $2\frac{1}{2}$ miles south of Hansen Dam. Pit 800 ft. by 1100 ft. by 150 ft. max. depth. Idle since 1943.
240	Granite Materials Co.-Tujunga Ave. plant	Granite Materials Co., Box 559, North Hollywood (1947)	32	2N	14W	SB proj.	Tujunga Wash, just south of Roscoe Blvd., between Tujunga and Fair Aves., about $2\frac{1}{2}$ miles south of Hansen Dam. Pit 500 ft. by 1000 ft. by 75 ft. deep operated 1932(?)-1947. Used for dumping pit in 1952.
241	Granite Materials Co.-Wick St. Plant		25	2N	15W	SB proj.	Tujunga Wash, west corner of Sharp Ave. and Wicks St., about $2\frac{1}{2}$ miles south of Hansen Dam. (Plate 5 herein.)
	John D. Gregg						See California Materials Co. and Consolidated Rock Products Co.-Irwindale plant No. 6.
242	Harvey	Sparks & Mundo Engineering Co., 1711 S. Soto, Los Angeles (1953)	1	1S	11W	SB proj.	West side of San Gabriel Wash, $\frac{1}{2}$ mile southwest of Arrow Rock Co. Duarte plant about $3\frac{1}{2}$ miles southwest of Azusa. Pit about 300 ft. by 400 ft. by 100 ft. deep, yielded sand, gravel, and crushed rock concrete aggregate prior to 1948; asphalt aggregate since then.
	Hewitt plant						See under Consolidated Rock Products Co. (Tucker 27:335)
243	Home Teaming & Transfer Co.	Home Teaming & Transfer Co. (1906)	15	1S	13W	SB proj.	Arroyo Seco at Ave. 22, East Los Angeles. Crushed rock for concrete produced in mill of 100 tons per day capacity in 1906. Long idle. (Aubury 06:317.)
	Kincaid plant						See under Consolidated Rock Products Co. (Tucker 27:343-344.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Largo plant						See under Consolidated Rock Products Co. (Tucker 27:344.)
244	Lindauer		32,33	2S	10W	SB proj.	South flank Puente Hills on Cypress, about $1\frac{1}{2}$ miles north of La Habra. (Kundert 52:21; plate 5 herein.)
245	Livingston Rock & Gravel Co.-Kincaid plant. (Builders Crushed Rock Products Co.)		32	1N	10W	SB proj.	San Gabriel Wash, about $\frac{1}{2}$ mile west of Irwindale Ave. and about 3/4 mile south of Foothill Blvd., about 2 miles west of Azusa. (Lenhart 50b:56-59,98; Tucker 27:334; plate 5 herein.)
	Livingston Rock & Gravel Co.-Rio Hondo plant	Livingston Rock & Gravel Co., W.H. Livingston, pres., 19 E. Valley Blvd., Alhambra	Approx	1N	11W	SB proj.	San Gabriel Wash (Rio Hondo), South Monrovia. Crushing and screening plant of about 80 tons per hour capacity; active about 1927. (Tucker 27:338.)
246	Los Angeles Rock & Gravel Co.	Los Angeles Rock & Gravel Co. (1921)	14	1S	13W	SB	Arroyo Seco, Ave. 35 and Pasadena Ave. Rock-crushing plant; 10 employees; active in 1906 and 1921. Long idle. (Merrill 19:485; Tucker 21:322.)
	Los Angeles Stone Co.						See Consolidated Rock Products Co.-Roscoe plant. (Merrill 19:485; Tucker 21:322.)
247	MacArthur & Son		18	4N	14W	SB	Santa Clara River wash, Soledad Canyon, 1/2 mile west of Lang. (Plate 5 herein.)
	Mahan						See Arrow Rock Co.-Sun Valley plant.
248	Manning Bros.		9	1S	10W	SB proj.	East side San Gabriel Wash, south of Bonita Ave. between Irwindale and Maxey Aves., southeast edge of Irwindale. (Plate 5 herein.)
	Material Dealers Distributing Co.	Material Dealers Distributing Co., H.W.	2(?)	2N	15W	SB proj.	Pacoima Wash, 1 mile east of San Fernando. Plant of about 40 tons per hour capacity; 10 employees; active 1927.

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Material Dealers Distributing Co. (cont'd)	Jones, pres., San Fernando (1927)					(Tucker 27:338.)
	McGregor	W.W. McGregor (1919)					Arroyo Seco, "near the Ostrich Farm", Pasadena. Small crushing plant (1919). Long idle. (Merrill 19:485.)
	Montrose		34(?)	2N	13W	SB proj.	Stream bed northwest of Glendale between La Crescenta and Montrose. Crusher built 1914, inactive by 1919. Long idle. (Merrill 19:486.)
249	Murphy Ranch	Murphy Ranch Co., P.O. Box 31, Whittier, (1952)	36	2S	11W	SB proj.	South flank of Puente Hills about 1/2 airline mile north of corner of Whittier Blvd. and West Rd., about 4 miles east of Whittier. Light-colored, clay-free sand of La Habra formation removed from open pit 40 ft. deep covering several acres. Operated 1939-1949 by 3 concerns producing untreated pit-run material for road surfacing. Area now within building subdivision, pit permanently closed. (Kundert 52:21-22.)
	National Plant						See under Consumers Rock & Gravel Co. (Tucker 27:335.)
250	Osborn Co. (Ducey & Atwood, Preston)		13,24	1N	12W	SB proj.	Eaton Wash, just below Eaton Wash Reservoir, northeast of Pasadena. (Tucker 27:338) (Plate 5 herein.)
251	Owl Rock Products Co.		1,2	1S	11W	SB proj.	West side San Gabriel Wash (Rio Hondo), just north of Arrow Hwy., just east of Peck Rd. Herein.
252	Pacific Rock Co.	Pacific Rock Co., Frank W. Aitkin, pres., San Fernando (1927)	15	2N	15W	SB proj.	Pacoima Wash, 1 mile southwest of San Fernando Blvd., north corner of Paxton St. and Sharp Ave., about 1 mile south of San Fernando. Pit excavated by steam shovel. Haulage by rail to plant for crushing and screening. Capacity 100 tons per hour; 10 employees in 1927. (Tucker 27:338.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Pacific Rock & Gravel Co.-Largo plant						See Consolidated Rock Products Co.-Largo plant. (Merrill 19:484; Tucker 21:322.)
	Pacific Rock & Gravel Co.-inactive plant (San Gabriel River Rock Co.)		32(?)	1N	10W	SB proj.	San Gabriel Wash, near Santa Fe R.R. tracks, about $2\frac{1}{2}$ m miles southwest of Azusa. Erected and operated by San Gabriel River Rock Co. prior to 1916, when flood damage forced moving of plant. Capacity about 200 tons per hour in 1921. Long inactive. (Merrill 19:484-485; Tucker 21:322.)
253	Pacific Rock & Gravel Co.		1	1S	11W	SB proj.	San Gabriel Wash, just south of Arrow Hwy., 0.7 miles east of Peck Rd., about $4\frac{1}{2}$ miles southwest of Azusa. (Plate 5 herein.)
254	Pacoima Dam quarry	Operated by Bent Bros. Construction Co., 5359 Valley Blvd., Los Angeles (1929)	24	3N	15W	SB	Pacoima Wash, about 1/2 airline mile southwest of Pacoima Dam, about $3\frac{1}{2}$ miles northeast of San Fernando. Pit provided 400,000 tons of concrete aggregate in period 1925-1929 for construction of Pacoima Dam. Hauled on inclined rail tramway to dam site. Idle since 1929.
255	Pacoima Rock & Gravel Co.	Alfred Canby, 11055 Telfair Ave., San Fernando (1952)	10	2N	15W	SB proj.	Pacoima Wash, 0.3 miles southwest of San Fernando Blvd., at Telfair Ave. Operated prior to 1925 by Pacoima Rock and Gravel Co. Idle since.
256	Parson macadam plant		15	1S	13W	SB proj.	Arroyo Seco, foot of Ave. 20, Los Angeles. Long idle. (Aubury 06:317.)
	Penrose plant						See Blue Diamond-Roscoe plant. (Tucker 27:335-336.)
	Pierson & Son						See Blue Diamond-Pierson plant. (Tucker 27:338.)
	Preston						See Osborn Co. (Tucker 27:338.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rancho Rock Co.	Rancho Rock Co., David E. Fulwider, pres., 917 Guaranty Bldg., Los Angeles (1927)	32(?)	2N	14W	SB proj.	Tujunga Wash, west of San Valley (Roscoe). Material delivered at crushing and screening plant by dragline bucket. Capacity 50 tons per hour; 8 employees in 1927. Long idle. (Tucker 27:338.)
	Redondo	H.O. Richwine, Gardena (1919)					Redondo. Sand pit yielded small tonnage for local use in concrete. Long idle. (Merrill 19:486.)
	Reliance Rock Co.						See Consolidated Rock Products Co.-Reliance plant. (Tucker 27:339-340.)
	Richwine						See Bixley and Redondo. (Merrill 19:486.)
	Rivas plant						See Union Rock Co.-Rivas plant. (Tucker 27:344-345.)
	Roscoe plant						See Consolidated Rock Products Co.-Roscoe plant. (Tucker 27:336.)
	Russell-Greene-Foell						See Consolidated Rock Products Co.-Baldwin Park plant. (Merrill 19:485; Tucker 21:322.)
257	San Fernando Rock Co.	San Fernando Rock Co., H.S. Wood, owner, 1006 Wright & Callender Bldg., Los Angeles (1919)	2,3, 10	2N	15W	SB proj.	Pacoima Wash, north corner of San Fernando Blvd. and Brownell Ave., southeast edge of San Fernando. Crushing plant operated prior to 1920. Idle since. (Merrill 19:486.)
	San Gabriel River Rock Co.						See Pacific Rock & Gravel Co.-inactive plant. (Merrill 19:484-485.)
	Sheldon plant						See under Consolidated Rock Products Co. (Tucker 27:337.)
258	Edward Sidebotham and Sons, Inc.		35	4S	14W	SB proj.	Northeast slope Palos Verdes Hills, south end of Pennsylvania Ave., south edge of Lomita. (Tucker 27:340; Woodring 46:120) (Plate 5 herein.)

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Sierra plant						See under Consolidated Rock Products Co.
259	Sierra Rock Products Co.		1,2	1S	11W	SB proj.	San Gabriel Wash, just south of Arrow Hwy., ½ mile east of Peck Rd., about miles southwest of Azusa. (Plate 5 herein)
260	Southern Counties Rock Co	Blue Diamond Corp., 1650 S. Alameda St., Los Angeles (1953)	1	1S	11W	SB proj.	West side of San Gabriel Wash, 0.3 miles west of Arrow Rock Co. Duarte plant about 3½ miles southwest of Azusa. Pit covering about 4 acres on Blue Diamond property, inactive since 1936.
261	Stine & Ellis	Stine & Ellis Rock Products Co., W.L. Stine, pres., Burbank (1927)	8	1N	14W	SB proj.	Tujunga Wash, northwest corner of Vineland Ave. and Victory Blvd., about 1 mile west of Lockheed Air Terminal. Pit 600 ft. by 800 ft. in plan excavated by 2-yd. dragline that delivered material to plant. Capacity 75 tons per hour; 3 employees in 1927. Long idle. (Tucker 27:340.)
	Sunset Rock Products Co.	Sunset Rock Products Co., R.W. Clark, mgr., 6372 Hollywood Blvd., Hollywood (1927)	18(?)	2N	14W	SB proj.	Tujunga Wash, vicinity of Hansen Dam ("2 miles north of San Fernando Blvd., 1 mile east of Osborne Ave., Burbank") Material moved from pit by dragline bucket to plant for crushing and screening. Capacity 250 tons per hour; 25 employees in 1927. (Tucker 27:340.)
262	Torrance Sand & Gravel Co.		27	4S	14W	SB proj.	Northeast edge Palos Verdes Hills, 1/8 mile west of Crenshaw Blvd., ¼ mile south of Pacific Coast Hwy., about 1 mile southeast of Walteria. (Plate 5 herein.)
263	Transit Mixed Concrete Co.		2	5N	11W	SB	Little Rock Wash, just north of Pearblossom Hwy. (Ave. T.), 2 miles northwest of Little Rock. (Plate 5 herein.)
	Tujunga Rock Co.						See Consolidated Rock Products Co.-Roscoe plant. (Merrill 19:485.)
	Union Rock Co.	Union Rock Co., George A. Rogers, pres., (1927)					Six plants, five in San Gabriel Wash and one in Tujunga Wash, with combined capacity of about 1750 tons per hour in 1927. Operated and later acquired Azusa holdings of

ROCK PRODUCTS - SAND AND GRAVEL (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Union Rock Co. (cont'd)						Pacific Rock and Gravel Co. Merged to form Consolidated Rock Products Co. in 1929. (See Baldwin Park, Durbin, Kincaid, and Largo plants under Consolidated Rock Products Co.) (Tucker 21:322; 27:340-345.)
	Boulevard plant	Union Rock Co. (1927)					Tujunga Wash, San Fernando Valley. Capacity 250 tons per hour. (Tucker 27:340.)
264	Rivas plant	Union Rock Co. (1927)	28,29	1N	10W	SB proj.	San Gabriel Wash, just north of Foothill Blvd., about 2 miles west of Azusa. Pit about 300 yards by 600 yards by 70 ft. deep; 75% coarse gravel and boulders. Excavated by power shovel; hauled by rail to plant for crushing, screening, and washing. Capacity 300 tons per hour; 30 employees. Five hundred-ft. water well. Inactive since merger with Consolidated Rock Products Co. in 1929. (Tucker 27:344-345.)
265	Western Rock & Sand Co.	Western Rock & Sand Co. 2599 E. 26th St., Los Angeles (1919)	10	2S	13W	SB proj.	Los Angeles, east bank of Los Angeles River, at end of 26th St. Pit 400 ft. by 750 ft. by 50 ft. deep active about 1919. Long idle. (Merrill 19:486.)
	Woods						See Azusa Rock & Sand Co.

ROCK PRODUCTS - SOAPSTONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
266	Arrow Point deposit	Santa Catalina Island Co. Avalon (1953)	15(?)	8S	16W	SB proj.	Santa Catalina Island, Arrow Pt., 4 miles east of western tip of island on north coast. Soapstone quarried on small scale by Indians; inactive for many years. (Renton, Malcolm: personal communication, 1953.)
	Banning (Empire Landing) quarry						See in dimension stone (serpentine) section. (Aubury 06:147; Crawford 94:402; 96:639; Merrill 19:483; Preston 90b:280; Tucker 27:331.)
	Bouquet Canyon talc	H.F. Nelles, 1308 Huntington Drive, South Pasadena (1921)	Approx	6N	14W	SB	Thirteen miles west of Palmdale on steep hillside, about 1,000 ft. above valley floor. Body of green talc 14 ft. wide exposed for 200 ft. along serpentine-schist contact. Much broken at surface. Explored by 70-ft. adit. Material suitable for marking crayons and tires, not white enough for talcum power. Production, activity undetermined. Idle. (Tucker 21:321.)
	Commack talc deposit	J.R. Commack, 1943 Wilcox Ave., Hollywood (1921)	Approx	6N	14W	SB	North side of Bouquet Canyon, 16 miles northeast of Saugus. Body of greenish talc 7-10 ft. wide dips 60° on contact of schist and quartzite. Shattered materials, no solid masses exposed. Production, development undetermined. Idle. (Tucker 21:321.)
	Dabney talc	C.G. Dabney, 1749 N. Cahuenga, Hollywood (1921)	Approx.	6N	14W	SB	Ridge slope northwest of Bouquet Canyon, 16 miles northeast of Saugus, adjoining Commack deposit. Body of greenish talc 25-50 ft. wide dips 60° in chloritic schist. Explored by open cut, exposing fair grade material. Production undetermined but small. Idle. (Tucker 21:321.)
267	Katz soapstone	Dr. Leon Katz, 9837 Foothill Blvd., San Fernando (1953)	8	5N	13W	SB	South flank of Sierra Pelona, $\frac{1}{2}$ mile north of highway at Boiling Pt., about $5\frac{1}{2}$ airline miles northwest of Acton. (Herein.)

ROCK PRODUCTS - SOAPSTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Soda Products Co.	Soda Products Co., J.L. Clark, E.S. Gates et al., 1724 Highland Ave., Los Angeles (1921)	Approx	6N	14W	SB	Southeast side of Bouquet Canyon on steep hillside about 1,000 ft. above valley floor, about $13\frac{1}{2}$ miles northeast of Saugus. Body of greenish talc on chlorite schist-serpentine contact, fractured on surface. Explored by open cuts. Material suitable for marking crayons. Production undetermined. Idle. (Tucker 21:321.)

ROCK PRODUCTS - SPECIALTY SANDS (FOUNDRY)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Harry E. Blood Co.	Harry E. Blood Co., 5028 Alhambra Ave., Los Angeles					Distributor of various foundry sands produced by L.I. Liston Co. according to specifications. Owner of several depleted deposits formerly operated by Liston. (Wright 48:51-54.)
	Brumley-Donaldson Co.	3050 E. Slauson Ave., Huntington Park					Distributor of various foundry sands produced by L.I. Liston Co. according to specifications. (Wright 48:51.)
268 269	Caswell No. 77, and Caswell No. 99		4 5	4S 4S	14W 14W	SB SB proj.	Two pits in Torrance-Redondo area: #77 pit at Madrona Ave. and Del Amo Blvd., about 2 miles northwest of central Torrance; #99 pit south of 190th (Domingues) St. opposite Rindge Lane, about $3\frac{1}{2}$ miles northwest of central Torrance. (Wright 48:51-54; plate 5 herein.)
	El Segundo beach sand						See Gordon Transfer & Trucking Co. (Wright 48:43.)
	Gordon Transfer & Trucking Co.	Gordon Transfer & Trucking Co., 907 Main St., El Segundo	11	3S	15W	SB proj.	East side of beach dunes at south end of Hillcrest Ave., El Segundo. Naturally-dried dune sand produced, untreated primarily for sandblasting (which see). Small amount sold for core sand for gray iron castings. (Wright 48:43; plate 5 herein.)

ROCK PRODUCTS – SPECIALTY SANDS (FOUNDRY, Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
270	Lawrence I. Liston Co.,-Madrona Ave. pit		9,10	4S	14W	SB proj.	Several pits in Torrance-Redondo area: Madrona Ave. pit northeast corner of Madrona Ave. and Torrance Blvd., about $1\frac{1}{2}$ miles west of Torrance; Redondo Beach Blvd. pit at southeast corner of Santa Fe railroad tracks and Redondo Beach Blvd., about $3\frac{1}{2}$ miles northwest of Torrance. Producers of foundry sands according to various specifications for Harry E. Blood Co. and Brumley-Donaldson Co. (Wright 48:51-54; plate 5 herein.)
	Los Angeles Heavy Molding Sand						See Westlake & Sons. (Wright 48:50-51.)
	McIlroy Blasting Sand Co.						See in sandblasting sand section.
	Miller Bros. Truck Co.,						Two pits in Torrance-Redondo area: #7 pit at 2726 Redondo Beach Blvd., about $3\frac{1}{2}$ miles northwest of central Torrance; #15 pit on Madison Ave., about 3 miles west of Torrance. (Plate 5 herein.)
271	Vollmer pit, and		32	3S	14W	SB	
272	Hawthorne pit		16	4S	14W	SB proj.	
273	Quartz Hill deposit		20	2N	13W	SB proj.	Northeast edge of Verdugo Mts., between Foothill Blvd. and end of Pali Ave., about 1 mile southeast of Tujunga. (Wright 48:43-44; plate 5 herein.)
	Paramount Sand Co.						See in sandblasting sand section.
	Walter D. Ransom						See in locomotive sand section.
	Torrance Lobond Molding Sand						See Brumley-Donaldson and L.I. Liston. (Wright 48:51.)
	Torrance-Redondo Molding Sand						See Harry E. Blood, Caswell, and L.I. Liston. (Wright 48:51-54.)

ROCK PRODUCTS - SPECIALTY SANDS (LOCOMOTIVE)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Westlake & Sons (Los Angeles Heavy Molding Sand)						Active pit at northeast edge of Elysian Heights, southeast side of Riverside Drive, opposite Rich St.; inactive pit at end of Effie St. in Elysian Park. (Wright 48:50-51; plate 5 herein.)
274	Active pit		9	1S	13W	SB	
275	Inactive pit		16	1S	13W	SB proj.	
	Consolidated Rock Products Co., Irwindale Plant No. 7						See in section on miscellaneous specialty sands.
	Leibee	Leibee Engineering Co. 124 W. 6th St., Los Angeles	13,14	3S	15W	SB proj.	Standard Oil Co. storage tank area, Manhattan Beach. Predecessor of Walter D. Ransom Co., producing locomotive sand from sand dunes 1931-1947.
276	Walter D. Ransom (Leibee)		13,14	3S	15W	SB proj.	Standard Oil Co. storage tank area, 1/4 mile north of Rosecrans Ave., about 1/4 mile east of Pacific Coast Blvd., Manhattan Beach. (Plate 5 herein.)

ROCK PRODUCTS - SPECIALTY SANDS (SANDBLASTING)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Richard R. Ball						See in sand, gravel, and crushed rock section. (Woodring 46:120; plate 5 herein.)
	Consolidated Rock Products Co., Irwindale plant No. 7						See in miscellaneous specialty sand section.
277	Gordon Transfer & Trucking Co.		11	3S	15W	SB proj.	East side of El Segundo beach sand dunes, south end of Hillcrest Ave., El Segundo. See in foundry sand section. (Plate 5 herein.)
278	McIlroy Blasting Sand Co.		11	3S	15W	SB proj.	East side of El Segundo beach sand dunes, west end of Pine Ave., El Segundo. (Plate 5 herein.)
279	Paramount Sand Co.		11	3S	15W	SB proj.	East side of El Segundo beach sand dunes, west end of Oak Ave., El Segundo. (plate 5 herein.)

ROCK PRODUCTS - SPECIALTY SANDS (MISCELLANEOUS)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Richard R. Ball						See in sand, gravel, and crushed rock section. (Woodring 46:120; plate 5 herein.)
280	Consolidated Rock Products Co., Irwindale Plant No. 7		8,9	1S	10W	SB proj.	Immediately adjacent to Consolidated Rock Products Co. Irwindale plant No. 6, east side of San Gabriel Wash, south of Bonita Ave., between Azusa Canyon Rd. and Irwindale Ave., about 1/4 mile southwest of Irwindale. (Plate 5 herein.)

SALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
281	Lake Salinas	Undetermined	6	4S	14W	SB proj.	Redondo Beach. Saline lake 3/5 mile long, 4-6 ft. deep, containing heavy concentrations of magnesium and sodium chloride, formerly equipped with salt works. Operation appeared unsuccessful and all works removed in 1901; vat work and small-scale solar evaporation in 1902. Operations abandoned since at least ten years prior to 1919. Idle. (Bailey 02:122; Merrill 19:512-513; Preston 10:281.)
282	Long Beach Salt Co.	Long Beach Salt Co., (Subsidiary of Western Salt Co.,) 2476 Hunter St., Los Angeles. Leased from Union Pacific Railroad Co.	3	5S	13W	SB proj.	Marshes adjacent to Terminal Island, between Wilmington and Long Beach. (Merrill 19:511; Sampson 37:207; Tucker 27:329-330; herein.)

SILICA

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Clayton						See Western Silica Co. (Merrill 19:513.)
283	Davis and Son	W.V. Davis, Box 214, Azusa	37	2N	9W	SB	East Fork of San Gabriel Canyon, about 7 airline miles north of Glendora. (Herein.)
	Joslin	C.E. Joslin, 900 Braly Bldg., Los Angeles (1906)	8?	5N	13W	SB	About 6 miles northwest of Acton. Thirty-ft. wide quartz vein of reported high purity opened in 1906. Production undetermined. Idle since prior to 1915. (Aubury 06:277; Merrill 19:513.)
	Los Angeles Silica Corp.	Los Angeles Silica Corp., 309 Central Bldg., Los Angeles (prior to 1919)	34	3N	14W	SB	Southern San Gabriel Mts., east of Little Tujunga Canyon, about $2\frac{1}{2}$ miles north of Sunland. Sedimentary deposit of quartz sand too impure for use in glass. Undeveloped location. Idle since prior to 1919. (Merrill 19:513.)

SILICA (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Muroc						See Western Silica Co. (Sampson 31:438.)
	Ohio	Ohio Valley Construction Co., John Schrader, Mgr., Marsh-Strong Bldg., Los Angeles (1919)	16	4N	14W	SB	Soledad Canyon, 1/2 mile west of Ravenna. Silica deposit worked in 1919. Production undetermined. Long idle. (May be same as Caliproducts feldspar deposit.)(Merrill 19:513.)
284	Quartz Hill (Quartz Mountain)	E.T. Earle estate, Los Angeles (1931)	6	6N	12W	SB	Quartz Hill, about $5\frac{1}{2}$ miles southwest of Lancaster. Quartz vein 75 ft. wide traceable westward through Pelona schist for $\frac{1}{4}$ mile. White, milky quartz low in impurities shipped to Los Angeles in 1906 for bottle glass. Production undetermined. Long idle. (Aubury 06:277; Merrill 19:513; Sampson 31:439; Simpson 34:414.)
	Quartz Hill						See under foundry sand.
	Quartz Mountain						See Quartz Hill. (Sampson 31:439.)
285	Western Silica Co. (Clayton, Muroc)	Edward Preste, Montrose (1931). Operated by Western Silica Co., P. Carney, pres., Los Angeles (1923)	15	7N	9W	SB	Mojave Desert, 18 miles east of Lancaster, 13 miles southeast of Muroc. Wide vein of bull quartz, reported 98% silica, mined by open cuts. Two cars per week shipped to Los Angeles in 1923 for use in glass. Total production undetermined. Long idle. (Merrill 19:513; Newman 23b:61; Sampson 31:438.)

ANNUAL REPORT OF THE STATE MINERALOGIST
CHIEF OF THE DIVISION OF MINES

FOR THE
105TH FISCAL YEAR
JULY 1, 1953 TO JUNE 30, 1954

By Olaf P. Jenkins *

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* State Mineralogist and Chief of the Division of Mines, Department of Natural Resources.

11—98522

LETTER OF TRANSMITTAL

Mr. DeWitt Nelson
Director, Department of Natural Resources
Sacramento, California

Sir: I have the honor to transmit herewith for reference to Governor Goodwin J. Knight the annual report of the State Mineralogist, Chief of the Division of Mines, for the 105th fiscal year, July 1, 1953, to June 30, 1954. This is in accordance with the requirement in amended Section 2203 of the Public Resources Code. Sections of the Code are quoted throughout the report to give documentary evidence of what is required of the Division of Mines and to show that the program followed adhered to the Code.

In this report the activities and accomplishments of the Division of Mines during the fiscal year 1953-54 are summarized. For the reason that the staff is better trained and organized and has been given equipment better suited to carry on this work, more has been accomplished during this period than ever before. A greater interest has been taken by the public and there has been an increased demand for technical information. The rapid expansion of the state's population and industries have called for more assistance in obtaining satisfactory local supplies of mineral raw materials, especially in the nonmetallic field.

Distribution of the Division's publications has shown a marked increase: 22 percent increase in circulation of *Mineral Information Service* and 62 percent in sales of documents. Service extended to the public in the laboratory also increased 22 percent.

Production of minerals in California reached an all-time high in 1952, to be exceeded in 1953, when production reached approximately $1,329,038,000 or 9 percent higher than in 1952. This production value represents 80.3 percent in fuels, 16.2 percent in nonmetallics, and 3.5 percent in metals.

Hundreds of letters commending the work of the Division of Mines attest to its value to the mineral industry and to the general education of the public as regards the natural mineral resources of the state. There is no doubt that the Division has contributed very materially to the economic expansion of California.

Respectfully submitted,

Olaf P. Jenkins
State Mineralogist and
Chief of the Division of Mines

Ferry Building, San Francisco
September 1, 1954

ABSTRACT

Public Resources Code:

"2203. The State Mineralogist shall make an annual report to the Director for transmission to the Governor on or before the fifteenth day of September next preceding the regular session of the Legislature."

This annual report concerns the activities of the Division of Mines for fiscal year 1953-54. No new positions were added to the staff. Expenditures increased only 7 percent which is hardly equivalent to increased costs of equipment, supplies, service, wages, as well as increased rent for new quarters in the Ferry Building. Expenditures for 1953-54 were $478,592. During moving, many of the Division's regular activities were curtailed because all staff members were required to spend several weeks in the rearrangement of the mineral collections.

The number of people served by the office section on information service increased 3 percent over the previous fiscal year. Circulation of the monthly pamphlet *Mineral Information Service* increased 22 percent. Distribution of technical publications increased considerably, as indicated in 62 percent increase in sales: $22,626.84 in 1952-53; $36,671.23 in 1953-54. Geologic guidebooks, histories of mineral development, *The evolution of the California landscape,* the legal guide, and studies of uranium were among the most popular publications. Large sales of geologic reports were made among members of the oil industry. The largest number of letters commending the work of the Division referred particularly to *Mineral Information Service.* Several reports required reprinting.

Mineral Information Service covered in particular the subjects of volcanic rocks, perlite, small scale gold placer mining equipment, lithium compounds, clay in Los Angeles County, diatomite, manganese, petroleum, salt, fluorescence of minerals, stone quarries, mica, early oil mining, landslides, defense minerals program, glass sand, and mineral production. The *California Journal of Mines and Geology* covered reports on flotation of titanium, adsorbent clays, history, and mineral inventory reports on Kings, Mendocino, Amador, Lake, and Santa Clara Counties, and the annual report of the State Mineralogist. *Bulletins* covered the subjects of chromite, geologic reports on Eel River area, and Lower Lake, Ortigalita Peak, and Breckenridge quadrangles, all with maps showing geology, mines, mineral deposits. *Special Reports* covered geology of Johnston Grade, Griffith Park area, strontium, Santa Rosa lead mine, tungsten of Madera, Fresno, and Tulare Counties, Palen Mountains gypsum, Rosamond uranium, and Barstow barite.

Reports in press include bulletins on the geology of southern California, clay technology, and Barstow quadrangle; special reports on Calaveritas, Angels Camp, Sonora and Ubehebe Peak quadrangles, and talc of Silver Lake; journals on the mineral inventory of Los Angeles County, and Cool-Cave Valley limestone.

Staff members made considerable progress in studies of various mineral commodities including clays, bentonite, sand, gravel, lightweight aggregates, shale, pumice, pumicite, volcanic cinders, obsidian, perlite, limestone, dolomite, cement, salt, lithium, salines of various kinds, talc, wollastonite, tungsten, lead, zinc, nickel, asbestos, petroleum, peat, and many others.

Mineral inventory reports on several counties including San Mateo, Marin, Shasta, Trinity, Imperial, Sacramento, San Joaquin, Calaveras, El Dorado, and Tulare were in progress. A geologic map and report of the Barstow quadrangle were completed for publication; geologic map of San Fernando quadrangle was completed, report was in preparation. Progress was made on quadrangles of Matterhorn Peak, Shoshone, and Tecopa. Reports on mineral deposits of Hernandez Valley, Santa Ysabel, and Lake Elsinore quadrangles were prepared. Historical report on hydraulic mining and report on use of rhyolite tuff as building and decorative stone are in progress. Report on Island Mountain sulfides was completed.

Progress was made on the new state geologic map (8 sheets in press, 8 in preparation).

Bulletins on the geology of southern California, on earthquakes of Kern County, on all mineral commodities of California, on pumice and obsidian, on salt, were nearly completed or well under way.

Demands for services increased, especially for information on uranium, on the so-called nonmetallics, or industrial minerals, and on strategic minerals and stockpile programs. The laboratory reported upon 5,036 samples of minerals, an outstanding accomplishment representing 22 percent increase over previous 1952-53 fiscal year (4,138 samples). Mineral exhibits, which were very greatly improved and extended, are now located in one large well-lighted room. In spite of the move, the library showed increases in many services, especially in the use of the periodical reading room, use of technical books by visitors, and loans of technical films. Staff members contributed talks and attended about the same number of technical meetings (170) in 1953-54 as during the previous year (171).

Cooperation with the Federal Bureau of Mines and Geological Survey continued satisfactorily. Statistical data processed for publication are provided by the Bureau, while geologic reports based on an active program of mapping are contributed by the Survey. The six field projects conducted by the U.S. Geological Survey on the cooperative program with the State Division of Mines include: East Shasta copper, Ubehebe lead-zinc, Bishop tungsten, Darwin lead-zinc, Eastern Sierra tungsten, and Sierra Foothills copper and gold. For the first three of these field work is completed and reports on the mineral deposits have been prepared; field work on the other three is being continued into the next fiscal year.

The Division of Mines has kept in step with new developments in the mineral industry, not only of California but of the rest of the nation, and has assisted in providing useful and authentic technical information. Many out-of-state investors request information on California. The mineral production of the state reached an all-time high in 1952 ($1,219,425,901) but that record was exceeded in 1953 ($1,329,038,000), a 9 percent increase. Mineral fuels represent 80.3 percent, nonmetallics 16.2 percent, metallics 3.5 percent of the total value in production. No figures are available to show added wealth after minerals are processed for industry, but the final total wealth is many fold that of the value of these raw materials.

INTRODUCTION

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State. . . ."

"2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

Functions of the Division. Since all mineral substances are included in the studies of the Division of Mines, according to the Public Resources Code, and since California is known to be endowed with more than half of all definite mineral species described, the scope of the Division's work is very broad indeed. Of 534 different species of minerals known to occur in California, about 70 are considered mineral commodities and given special study because they are of commercial value. There probably is no other area on this earth that has a greater diversity of mineral and rock types than California. Many of the mineral deposits, though not mined today, are very important as possible future producers. It is extremely important to know how and when these potentially valuable deposits may become useful and marketable.

Scope of Work of the Division. The Division of Mines' work concerns all the mineral commodities of the nation. Most of these are either produced in California or represent potential sources of wealth. In any case, staff members of the Division must keep alert on the occurence of all minerals, their possible usefulness, and their sources either from California deposits or from deposits in other parts of the nation or world.

The following list shows clearly that California is most richly endowed with mineral wealth since few of these mineral commodities are neither mined nor occur as potential sources in the state. To learn adequately of the state's mineral deposits whether currently economic or not, basic studies in geology are imperative. These include basic geological surveys and mapping, basic laboratory research, careful mineralogical determinations, and the analyses of various related scientific problems. Furthermore, economic development by industry must be carefully followed. The utilization of minerals by industry must be understood and the specifications of mineral raw materials must be learned. As this information is acquired, the scientific and economic factors may be integrated.

The scope of the work of the State Division of Mines parallels that of the federal Geological Survey and federal Bureau of Mines with both of whom the Division cooperates and works in close harmony. Cooperation extends also to the geological departments of the several universities of the state and to similar research departments of other scientific and commercial organizations. Without this mutual understanding and cooperative endeavor, the progress of the Division of Mines would be very limited. As it now operates, the public benefits by the service it renders as a clearing house for information from all sources regarding the minerals and rocks of California.

In the following list of mineral commodities produced or utilized in the United States, those marked with an "X" are not known to occur in California; those marked with an "O" are known to occur in California but either have never been mined or have not been processed here; those marked with a "V" are not being produced commercially at present in California but have been in the past. The remainder are being produced from California deposits.

Mineral commodities of the United States.

Naturally occurring mineral commodities

Abrasives
Agate
Agricultural limestone
V Alunite
O Anatase
V Andalusite
Anhydrite
Anorthosite
X Anthracite
Antimony
Antimony ores
O Apatite
Argon
Arsenic
Arsenic ores
Asbestos
X Amosite
V Chrysolite
O Crocidolite
Tremolite
Ashlar stone
Asphalt
Autunite
Ball clay
Barite
Basalt
Basnasite
O Bauxite
Bentonite
V Beryl
V Bituminous coal
V Bituminous rock
Black sand
Blast sand
Borates
Borax
O Brucite
Building gravel
Building sand
Building stone
V Cadmium ore
Carbon dioxide
O Carnotite
X Chalk
China clay
Chromite
Clay
Coal
Colemanite
Concrete gravel
Concrete sand
Conglomerate
Copper
Copper ore
V Cornwall stone
O Corundum
X Cryolite
Curbing
V Diamond
Diatomaceous earth
Diatomite
Dimension stone
Diorite
Dolomite
V Dumortierite
O Emery
Engine sand
V Epsomite
X Euclase
Feldspar
O Fergusonite
Filter sand
Fire clay
Fire sand
Flagging
Flint
V Fluorspar
Foundry sand
Fuller's earth
Gannister
Garden stone
Garnet
Gas
Gasoline, natural
Gem stones
O Gilsonite
Glass sand
Glauber's salt
Gold
Gold ore
Granite
Graphite
Gravel
O Greensand
Greenstone
Grinding pebbles
Grinding sand
O Grindstone
Gypsum
Gypsite
O Halloysite
Heavy clay products
O Helium
Hydrogen
Iceland spar
Ilmenite
Iron ores
Jade
Kaolin
O Krypton
V Kyanite
Laterite
Lead ores
Lignite
Limestone
Lithium ores
Magnesite
Magnetite
Manganese ores
Marble
Marl
O Meerchaum
Mercury
Mercury ores
V Mica
O Millstones
Mineral earth pigments
Limonite
Hematite
Ochre
Mineral wax
Mineral water
Molding sand
Molybdenum ores
O Monazite
Montmorillonite
O Muscovite
Natural gas
O Neon
O Nepheline syenite
O Nickel ores
O Niobium ores
O Nitrate materials
Nitrogen
Obsidian
O Olivine
Onyx
Ornamental stone
Oxygen
Oyster shells
V Paving blocks
Peat
Perlite
Petroleum
O Phlogopite
O Phosphate rock
O Pitchblende
Platinum
O Pollucite
Potash
Potash feldspar
Pumice
Pumicite
Pyrite
Pyrophyllite
Quartz
Quartzite
Rare earths
Rhyolite tuff
Riprap
V Rock crystal

- Rock salt
- Roofing granules
- V Roofing slate
- Rottenstone
- Rubble
- Salines
- Salt
- Salt cake
- Sand
- Sandstone
- V Sapphire
- Serpentine
- V Schist, mica
- Shale
- Silica
- V Sillimanite
- Silver
- Silver ores
- Slate
- Slip clay
- Soapstone
- Soda ash
- O Sodalite
- Soda salts
- Spodumene
- Steatite
- Stone
- Strontium ores
- Sulfur
- X Sylvite
- Talc
- O Tantalum ores
- Tar
- Terrazzo chips
- V Tin ores
- O Titanium ores
- Topaz
- O Torbernite
- Travertine
- X Tripoli
- Trona
- Tube-mill pebbles
- Tungsten ores
- Uranium ores
- O Uraninite
- O Vanadium ores
- Volcanic ash
- Volcanic cinders
- V Witherite
- Wollastonite
- X Wurtzilite
- O Xenon
- Zinc ores
- V Zircon

Refined metals and non-metals

- V Aluminum
- Antimony
- Argon
- O Barium
- O Beryllium
- V Bismuth
- Boron
- Bromine
- V Cadmium
- O Calcium
- Cerium
- O Cesium
- Chlorine
- O Chromium
- V Cobalt
- Copper
- O Gallium
- O Germanium
- Gold
- O Helium
- Hydrogen
- O Indium
- Iron
- O Krypton
- Lead
- Lithium
- Magnesium
- Manganese
- Mercury
- Molybdenum
- O Neon
- O Nickel
- O Niobium
- Nitrogen
- Osmiridium
- Osmium
- Oxygen
- Palladium
- O Phosphorus
- Platinum
- O Radium
- O Rhenium
- Rhodium
- O Rubidium
- Ruthenium
- O Selenium
- O Silicon
- Silver
- O Sodium
- Strontium
- Sulfur
- O Tantalum
- Tellurium
- O Thallium
- O Thorium
- V Tin
- O Titanium
- O Tritium
- O Tungsten
- O Uranium
- O Vanadium
- O Xenon
- Zinc
- O Zirconium

Processed mineral commodities

- Ammonia
- Borax
- Brick and tile
- Bromine
- Butane
- Calcium chloride
- Carbon dioxide
- Carbon black
- Cement
- Chlorine
- Coke
- Condensates
- V Epsom salts
- V Ferro alloys
- Fertilizers
- Filler materials
- Fuel oil
- Gasoline
- Iron
- Lime
- Liquefied petroleum gases
- Magnesia
- Magnesium compounds
- Magnesium chloride
- Masonry cement
- Mineral wool
- Mineral pigments from lignite
- Mineral wax
- Montan wax
- Natural gas gasoline
- Natural gas
- Petroleum products
- Portland cement
- Pottery
- Refractories
- Rochelle salts
- Shale, expanded
- Silica
- Slag
- Soda ash
- Soda salts
- Terrazzo
- V Umber
- Vandyke brown
- Wax

Typical Duties of the Division. Some of the principal duties of the Division of Mines are as follows:

(1) To inventory the economic mineral deposits of California.

(2) To make geologic surveys and maps covering all parts of the state to show the geologic formations, their composition, structure, and mineral content.

(3) To determine the composition of all minerals and rocks of the state.

(4) To study geologic processes in progress, such as the action of earthquakes, landslides, mineral springs, and erosion by running water.

(5) To make a record of the activities of mining and mineral industries, their productivity, and the methods used in processing minerals to make them useful.

(6) To provide the public with authentic information on the geology and mineralogy of California, its mineral resources, mining activities, and usefulness of its minerals in industry.

In providing the public with information, the following procedures are found to be effective: (a) Maintaining public displays and collections of minerals and models showing utilization of minerals. (b) Maintaining a reference library of published technical information. (c) Maintaining an information service office to answer inquiries of the public by personal interview, by correspondence, by telephone conversation, and by providing the public with authentic published data. (d) Maintaining files of topographic, geologic, mine, and mineral deposit maps of the state. (e) Publishing the results of surveys, research projects and investigations; providing the public libraries and institutions with this literature free of charge, or selling it to persons at cost of printing. (f) Providing, upon request, a set of common California minerals for each grade school, to inform the pupils and to assist the teachers. Schools are also provided with publications of the Division as they request them. (g) Giving illustrated lectures, on request, and providing leadership for field trips for interested groups.

As we enter a new fiscal year (1954-55) we pause to take stock of the work we accomplished the previous year, to review current projects, and to consider how best to proceed with new assignments. In this report for the fiscal year 1953-54, the requirements of the Public Resources Code are shown to have been a guide for the Division's work, which is closely integrated with the current needs of the mineral industry.

As a technical and scientific bureau, the Division maintains a well-trained staff of mining geologists; a splendid library on geology, mineralogy, mining, mineral processing, mineral industries, and all other related subjects; a laboratory suited to the determination of minerals and rocks; a large working collection of all kinds of minerals; and exhibits to show the usefulness of minerals and how they are extracted from the earth and processed to meet the specifications of industry.

In the pages to follow, the recent mineral production of California is summarized and the activities of the Division of Mines are reviewed for the fiscal year, 1953-54. These activities are shown to have distinctly increased. The Division has played a very important part in giving assistance to every branch of the mineral industry. The accelerated growth of the mineral industry during this period of rapid expansion in population is rapidly building a basic foundation of permanent wealth for this richly endowed great State of California.

FIGURE 1. Mining geologist utilizing part of Division's research equipment. Shown here is the petrographic microscope, equipped with Federov universal stage. This equipment enables researcher to orient specimen in any desired position.

THE MINERAL WEALTH OF CALIFORNIA

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

"2207. The owner, lessor, lessee, agent, manager, or other person in charge of any mine of whatever kind or character within the State shall forward to the State Mineralogist, upon his request, at his office, not later than the thirty-first day of March in each year, upon forms which will be furnished, a report showing the character of the mine, the method of working the mine and the general condition thereof, and the total mineral production for the preceding calendar year. Any such person who fails to comply with the provisions of this section is guilty of a misdemeanor.

Such reports shall be confidential. Other records are public records unless excepted by statute. Statistical bulletins based on these reports and published under the provisions of Section 2205 of this code shall be compiled to show, for the State as a whole and separately for each county, the total of each mineral produced therein, provided that, in order not to disclose the production of any operator, no production figure shall be published which represents the production of less than three operators; and when such production figure for any county would conflict with such provision it may be combined with such production figures for one or more other counties. Such bulletins shall be published annually by June 30th or as soon thereafter as practical."

For six consecutive years—1947-1953, inclusive—the annual value of minerals produced in California has exceeded one billion dollars. About 70 different mineral materials contribute to this natural treasure of the state and all go into the manufacture of a multitude of useful products—into the fuels and power of industry, into buildings, highways, and dams, and into the soil to replenish it for the growth of the agricultural products of the state. The value thus added to the state's minerals after they are processed for man's utilization is many fold that of the original raw material. The constant increase in the production and value of California's minerals is attributed to the constant increase in the state's population and its demand for useful products.

The estimated mineral production of California for 1953 of $1,329,038,000 establishes a new all-time record. This output exceeds the 1952 record of $1,219,425,901 by $109,612,099 or approximately 9 percent. All-time highs in annual values were shown by petroleum, natural gas, natural gas gasoline, liquefied petroleum gases, cement, sulfur, miscellaneous stone, iron ore, and tungsten ore. The precious metals, gold and silver, and the base metals, copper, lead, and zinc registered decreases in output, reflecting the relatively low prices offered for these mine products on the current market. The strategic metals such as chrome, iron ore, manganese, mercury, and tungsten ore showed increases in the production and value. Here the underlying stimulus has been the Federal Stockpile Program which guarantees a relatively high product-price for an extended period.

In terms of value, tungsten ranked first among the metals produced in California in 1953, followed by iron ore, and gold. The production of rare earth elements is increasing and exploration is active. Although no commercial production of uranium has yet been made, numerous occurrences have been reported, prospecting is very active, and future production is confidently expected.

Building in California has continued at an accelerated pace, resulting in increased demand for construction materials. The quantity and value of cement was at an all-time high. The production of crushed rock, sand and gravel, clay, gypsum, lime, limestone, and dolomite continued at high levels.

The production of most nonmetallic minerals continued to increase in 1953. Sulfur production in this year was greater than the total of all previous years in California. This was the result of open-pit large-scale operations at the Leviathan mine in Alpine County.

The collection and processing of mineral production statistics is carried on in cooperation with the United States Bureau of Mines. The final figures are published by the Division, first in *Mineral Information*

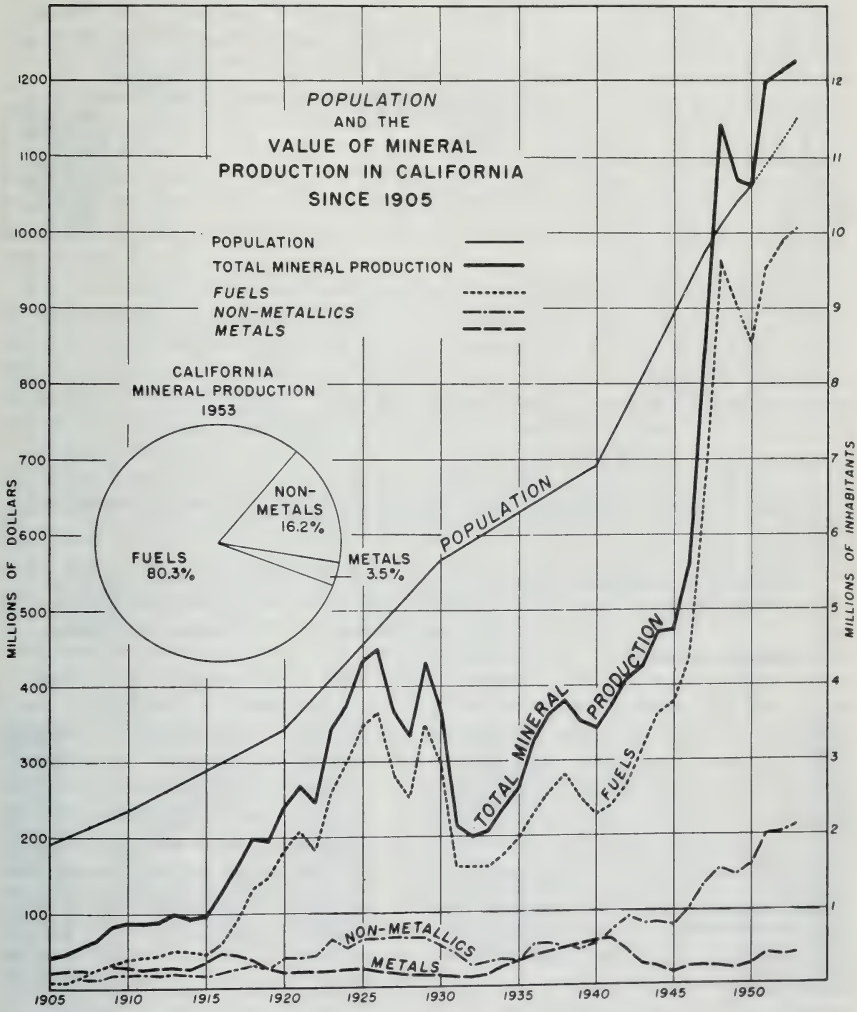

FIGURE 2. Graph showing relative value of mineral production in California.

Service, and finally in the *California Journal of Mines and Geology*. The Federal Bureau of Mines also publishes the data in their *Minerals Yearbook*.

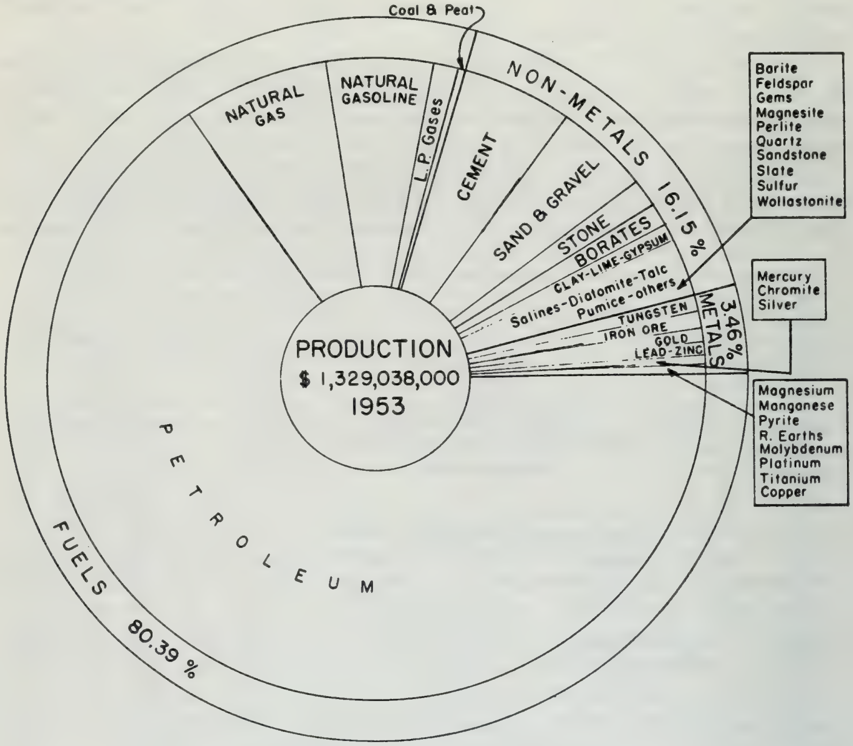

FIGURE 3. Graph showing relative value of the principal mineral commodities produced in California in 1953.

Summary of mineral production in California for the years 1952 and 1953.

Mineral commodity	Recorded 1952 production		Estimated 1953 production	
	Quantity	Value	Quantity	Value
Gold	258,176 fine oz.	$9,036,160	234,584 fine oz.	$8,210,685
Silver	1,099,658 fine oz.	995,246	1,036,372 fine oz.	937,969
Copper	1,600,000 lbs.	387,200	764,000 lbs.	219,268
Lead	22,398,000 lbs.	3,606,078	17,328,000 lbs.	2,269,968
Zinc	18,838,000 lbs.	3,127,108	10,716,000 lbs.	1,232,340
Iron ore	1,463,239 long tons	10,478,939	1,700,000 long tons	12,000,000
Mercury	7,241 flasks	1,441,683	9,290 flasks	1,793,249
Tungsten	178,779 units	11,360,569	213,210 units	12,792,600
Other metals		6,808,425		6,500,000
Petroleum	359,415,000 bbls.	801,882,000	365,000,000 bbls.	890,600,000
Natural gas	517,450,000 M cu. ft.	86,414,000	536,200,000 M cu. ft.	93,298,000
Natural gas gasoline	20,738,000 bbls.	64,945,000	21,675,000 bbls.	67,627,000
Liquefied petroleum gases	9,376,000 bbls.	16,700,000	9,466,000 bbls.	16,850,000
Cement	29,786,245 bbls.	79,457,745	32,003,000 bbls.	90,612,000
Miscellaneous stone	67,349,272 tons	61,316,230		62,000,000
Other nonmetallics		21,274,020		25,595,000
Salines		40,195,498		36,500,000
Total value		$1,219,425,901		$1,329,038,000

ADMINISTRATION

Public Resources Code:

"2201. The State Mineralogist shall employ competent geologists, field assistants, qualified specialists, and office employees when necessary in the execution of the plans and operations of the division under this chapter."

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State. . . ."

The Division of Mines represents one of the several divisions of the Department of Natural Resources. The office of the Director of the Department is in the State Building No. 1 in Sacramento. Headquarters offices of the Division of Mines and the office of its Chief, the State Mineralogist, are in the south wing of the Ferry Building, San Francisco. During the fiscal year 1953-54, the offices of the Division were moved from the north wing of the building, where they had been located for many years, to more adequate rooms, better arranged and lighted, and admirably suited to the work of the staff, to serving the public, and to displaying its fine collections of minerals, maps, and books.

The Division of Mines maintains three branch offices, the largest in Los Angeles and smaller offices in Sacramento and Redding, which are all effective in extending the services of the Division to the public and in contacting local industry and research workers. Each carries on many of the phases of the Division's work, except administrative, editorial, drafting, and laboratory.

In July 1954 the staff of the Division comprised 55 employees, 32 technical and 23 non-technical. The principal classification of the technical staff is that of mining geologist. Two Supervising Mining Geologists assist in the operations of the Division: (1) Business management and technical supervision of economic surveys, mining operations, and industrial examinations are the responsibility of L. A. Norman, Jr. (2) Personnel requirements and technical supervision of geological and mineralogical surveys are the responsibility of Gordon B. Oakeshott.

Most of the members of the technical staff are assigned major programs of objective research in addition to their routine duties. The results of the research projects are made available to the public through the Division's publications. All the technical work of the Division is carefully integrated. On the first Tuesday of each month the entire technical staff meets in the San Francisco conference room for the purpose of informally reviewing current field activities.

Manuscripts are processed for publication by technical employees in the editorial section, Elisabeth L. Egenhoff and Mary R. Hill. In addition to this work, Miss Egenhoff has been carrying on a study of the early history of mineral discovery and development, while Miss Hill has served as a technical photographer. As a result, a fine collection of excellent illustrative material has been accumulated of both present conditions and historical scenes.

Hundreds of maps, sections, and charts are prepared for publication in the Division's reports by the drafting section, comprised of three employees supervised by Richard A. Crippen, Jr. Mr. Crippen also carries on a mineralogical study of the rare nonmetallic minerals.

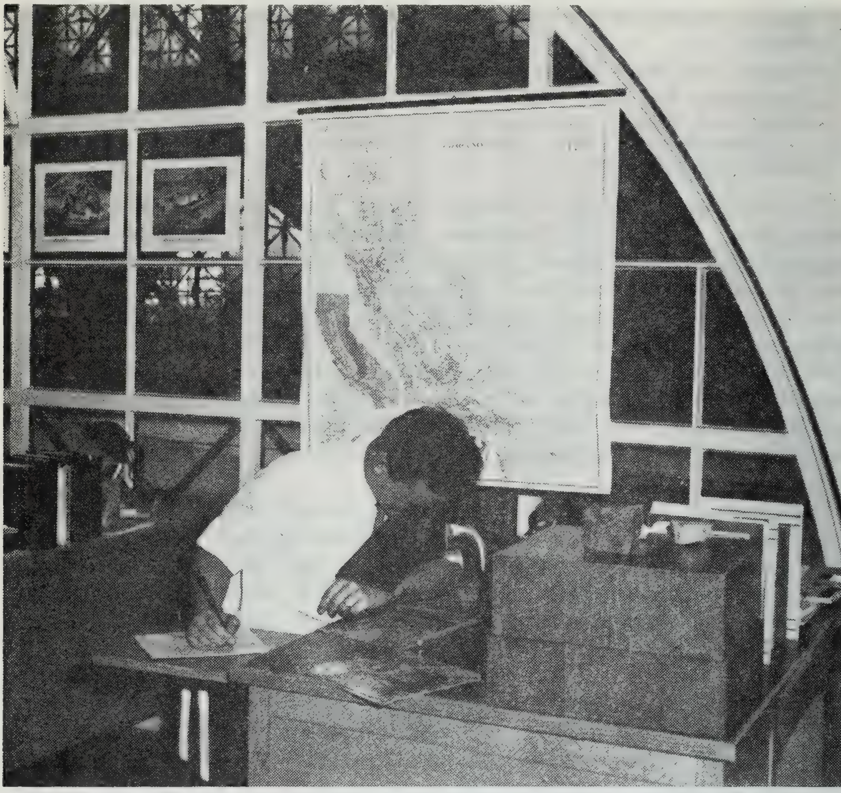

FIGURE 4. Offices for most Division staff members are in mezzanine of Ferry Building. Geologist in foreground is working with stereoscope, transferring data determined from viewing a stereoscope pair of aerial photographs to maps.

Generally two or more staff members are in attendance in the information section where the public is interviewed. Many technical questions are answered and technical publications of the Division are distributed over the counter. This information section is supervised by Fenelon F. Davis, who also carries on field studies of manganese and mercury and has recently been preparing a report on the mineral resources of San Mateo County. The information desk is also served by Henry H. Symons, who in addition is the Division's statistician.

The Division's technical library is one of the very best on the Pacific Coast, covering the subjects of mining, geology, mineralogy, industrial chemistry, and allied sciences. The Division's librarian, William A. Sansburn, is assisted by two and sometimes three other staff members. The file of topographic and geologic maps, which represents thousands of copies, is kept in systematic order by Jeanine Kazi-Girey. The

librarian occasionally visits other libraries in the state to see that the Division's publications are adequately serving the public. Technical motion pictures are distributed from the library; so also are school library kits, made up of publications of the Division, of special interest to teachers and students.

The work in the mineral laboratories and mineral exhibits is supervised by Charles W. Chesterman, who also is engaged in preparing a bulletin on pumice, pumicite, volcanic cinders, and obsidian, and has done considerable work on other lightweight aggregates such as perlite. He is carrying on geologic mapping in the Matterhorn Peak quadrangle.

The laboratory, in addition to serving the members of the staff, identifies minerals for the public. This requires at times two or three members of the staff and particularly the continuous work of George L. Gary. Though the Division has yet no regularly employed curator, Melvin C. Stinson is serving in this capacity part-time and has also been preparing a report on the results of his field investigations of the Island Mountain sulfides and has made a study of rare earth and radioactive minerals.

A statewide investigation is being carried on by the Division on limestone, dolomite, and cement materials. This work is supervised by Oliver E. Bowen, Jr., assisted by Cliffton H. Gray, Jr. and other members of the staff. Mr. Bowen has recently completed the geologic mapping of the Barstow quadrangle and has been reviewing the geologic projects now being carried on by various geologists in the Sierra Nevada. In particular, he has a report in progress on Mariposa County and on the Cherokee hydraulic mine. Mr. Gray has started a program of field mapping the limestones in the Gabilan Range of San Benito County.

A statewide investigation of the clay resources of California is one of the major current projects of the Division. It is being carried on by Mort D. Turner in cooperation with Professor Joseph A. Pask of the Ceramic Engineering Department of the University of California. As a result of this work, a bulletin on clay technology is in press, as well as several other papers. Mr. Turner has investigated the mineral deposits, principally clay, of the Lake Elsinore quadrangle, a deposit of bentonite in San Benito County, and has been working with Mr. Bowen on the study of the Cherokee hydraulic mine in which occurs potentially valuable deposits of quartz sands and clay.

A comprehensive investigation of the saline deposits of the state is being carried on by William E. Ver Planck, who is currently preparing a bulletin on the salt deposits in California. His bulletin on gypsum has recently been published, he has prepared a report on lithium compounds, and is currently studying the occurrences of boron minerals and other related saline deposits.

A special resumé study of all the mineral commodities in California is being undertaken by the Division in view of publishing a comprehensive bulletin on various phases of the subject. All members of the technical staff contribute to this bulletin. It is being edited by Lauren A. Wright, who also is in charge of the Los Angeles office. Dr. Wright has specialized particularly on the subject of talc and has done much

work in the region of Death Valley. He has made significant contributions to the Division's forthcoming bulletin on the geology of southern California, and has prepared a geologic guide through the desert area for this bulletin.

Considerable assistance is given by the Division of Mines to the petroleum industry through the publication of geologic maps by quadrangles. Many contributions are received from geologists who are members of university faculties or are graduate students. This work is supervised by Gordon B. Oakeshott, who has mapped the San Fernando quadrangle geologically. Dr. Oakeshott has made contributions to the Division's forthcoming bulletin on southern California and has managed and edited the preparation of the Division's forthcoming bulletin on the Kern County earthquakes.

More direct studies of mineral fuels have been carried on by Charles W. Jennings, who has worked particularly in the Ventura Basin and on the mineral deposits of the Hernandez Valley quadrangle. The revision of the Division's tabulated list of wells drilled outside of the oil fields is being carried on by Earl W. Hart. Mr. Jennings has also made investigations of commercial peat deposits.

The Division has been carrying on an extensive survey of mineral utilization in the state. This is supervised by L. A. Norman, Jr., who has frequently served as mediator of symposiums given by Division of Mines staff on mineral commodities and mining problems in California.

In the Los Angeles office, Richard M. Stewart has been carrying on a particular survey of mineral utilization in the southern California region and has prepared a large file of information. He has been studying the mineral deposits of the Santa Ysabel quadrangle and is preparing a report on San Diego County.

A statewide investigation of the sand and gravel deposits is being carried on by Thomas E. Gay, Jr. in the Los Angeles office, who also has a manuscript on the Coffee Creek area of the Klamath Mountains and has made studies of several mineral commodities.

Special studies on wollastonite and the geology of the Shadow Mountains are being carried on by Bennie W. Troxel of the Los Angeles office, who is currently preparing a report on Imperial County. He has contributed extensively to the Division's forthcoming bulletin on the geology of southern California.

A general review of the lead and zinc deposits of California has been prepared by J. Grant Goodwin, who has completed a general manuscript and statewide economic mineral map showing the location of these minerals. Mr. Goodwin is also preparing a report on Tulare County.

In the study of economic minerals which occur in the serpentine of California, Salem J. Rice has been particularly interested in the occurrences of asbestos and of low-grade nickel deposits in the weathered and lateritic surfaces of these ultrabasic rock areas. He has recently mapped the geology of the coastal area north of Eureka. Recently George B. Cleveland has been assisting in the study of the nickel deposits and the mineral commodities of titanium and zirconium.

In the revision of the new state geologic map, the compilation has been carried on by Charles J. Kundert, who also has been making a study of the barite deposits of California. In the Sacramento office,

studies are being carried on relating to the gold deposits of the Sierra Nevada. Denton W. Carlson has been working on county reports of Sacramento and Calaveras Counties; William B. Clark is engaged in preparing reports on San Joaquin and El Dorado Counties.

From the Redding office, J. C. O'Brien has been carrying on studies of the mineral resources of Shasta and Trinity Counties and has reviewed literature on copper and zinc.

In addition to the Division's studies on clay, sand and gravel, pumice and perlite, a new study on aggregates has been initiated. Berdine H. Rogers of the Los Angeles office, has started work on the testing of expansible shale, shale that can be expanded by furnace treatment to form a lightweight aggregate.

OUTLINE OF THE FUNCTIONAL ORGANIZATION OF THE DIVISION OF MINES

SAN FRANCISCO HEADQUARTERS:

Administrative Branch
- Personnel control
- Office management
  - Fiscal control
  - Maintenance and service
  - Stock and mailing
  - Janitor service
- Public information service
  - Distribution of publications
  - Public interviews
  - Correspondence
  - Public appearances
  - Laboratory service
  - Exhibits
  - Library
- Publication processing
  - Editorial section
  - Drafting section
- Cooperative programs
  - University research
  - Federal Geological Survey
  - Federal Bureau of Mines
- Regional state geologic map compilation

Geologic Branch
- Basic geologic survey (by quadrangle)
- Mineral commodities survey (by commodity)
- Laboratory research
- Manuscript control

Mining Engineering Branch
- Mining activities survey (by county)
- Mineral utilization survey (by industry)
- Mineral statistics
- Ore buyers licensing

LOS ANGELES OFFICE:
- Public information
- Surveys of mining activities, mineral commodities, mineral utilization, and basic geology.

SACRAMENTO OFFICE:
- Public information
- Mining activities

REDDING OFFICE:
- Public information
- Mining activities

FINANCIAL STATEMENT

A 7 percent increase in expenditures of the Division of Mines for the fiscal year 1953-54 over the fiscal year 1952-53 reflected the increased costs of equipment, supplies, services and wages. Approximately 32 percent of the increase was due to increased rent for the new quarters in the Ferry Building, the acquisition of which was necessary because of major construction work in the building. No new positions were added to the staff, but services rendered were considerably increased as summarized in other sections of this report.

Expenditures 1952-53 (actual) $446,193
Expenditures 1953-54 (not final) $478,592

EXPENDITURES

Fiscal 1953-54 *

Total salaries and wages		$274,777.47
Operating expenses:		
Freight, cartage and express	$1,412.53	
Telephone and telegraph	2,394.06	
Toll calls	473.80	
Light, heat, power	1,877.49	
Rent of building space	24,419.00	
Repairs and maintenance	599.98	
Office supplies and services	4,814.89	
Postage	8,426.48	
Photography, supplies and services	1,058.75	
Blueprinting	925.06	
Printing bulletins and maps	68,084.07	
Printing, general	2,384.86	
Technical reports	8,150.00	
Auto parts, services, gas, oil, tires, tubes	6,034.54	
Travel	14,058.55	
Auto mileage	380.56	
Moving	2,854.13	
Laboratory, supplies and services	3,731.70	
Library supplies and services	848.81	
Exhibits supplies and services	471.21	
Total operating expenses		$153,400.47
Equipment:		
Automobile	3,041.59	
Field	539.18	
Laboratory	3,992.77	
Office	1,950.96	
Library	1,401.50	
Exhibits	3,117.09	
Miscellaneous replacements	110.00	
Miscellaneous additional	1,261.46	
Total equipment		$15,414.55
Total expenditures		$443,592.49
Special item: Geological exploration in cooperation with U. S. Geological Survey		35,000.00
Grand total		$478,592.49

* Some of the figures given are approximate, because not all bills for the fiscal year were paid at the time this report was prepared.

FIGURE 5. New quarters for drafting room are at extreme end of south end of Ferry Building.

PUBLIC INFORMATION SERVICE

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall:

. . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State. . . ."

Many important contacts between the public and the Division of Mines are made through its public information section which handles personal interviews, telephone calls and letters of inquiry. A plan of rotating assignments in this section affords each technical staff member the opportunity of thus meeting the mining public, and makes him cognizant of the practical current problems involved in the business of mining.

During the past year many of the inquiries have centered around the strategic mineral and stockpile programs of the U. S. Government. Information on source of materials, specifications, prices, duration of programs and destination of ores is in constant demand.

The atomic bomb tests conducted by the armed forces both on land and at sea have made the public energy-conscious. Consequently, the search for fissionable raw materials which began in the Rocky Mountain area has spread rapidly to the Pacific Coast. In another year California could conceivably be in the throes of a uranium boom.

The impetus of these factors upon the information section is shown in the following tabulation of services provided during the past two years.

Information Services

Personal services (correspondence, telephone, and visitors)	*1952-53*	*1953-54*	*Percent change*
San Francisco office	43,309	44,932	+4
Los Angeles office	19,472	19,155	—1
Sacramento office	2,719	4,048	+33
Redding office	2,079	1,873	—10
Totals	67,579	70,008	+4
Various services			
Incoming pieces of mail (San Francisco)	47,568	48,854	+3
Outgoing pieces of mail (San Francisco)	234,016	304,152	+30
Museum education tours			
Groups	77	64	—20 *
Persons	3,001	2,325	—29 *
Mineral Information Service			
Average monthly circulation	16,290	19,822	+22

* Museum closed for four months while being moved and reclassified.

Letters of commendation are received almost daily—from company officials, geologists, engineers, lawyers, teachers, miners, prospectors and laymen—attesting that the Division's services are accepted by a wide and appreciative audience.

Among the various other types of information provided by the Division of Mines during the year were:

(1) *Basic Geologic Data.* Examples of services rendered: Furnished information on the geology of the Santa Maria District to an oil company; conferred with an American Association of Petroleum Geologists representative on a correlation chart of the Sacramento Valley; assisted a geologist from the Nevada State Bureau of Mines in a study of California Division of Mines services; supplied reports on geology of specific areas and on strategic minerals such as: chromite, manganese, quicksilver and tungsten; recommended books on rocks and minerals for amateur reading.

(2) *Sources of Mineral Raw Materials.* Examples of services rendered: Directed a Texas oil well-logging firm to literature on California stratigraphy; furnished a Pennsylvania coal operator with information on California coal and lignite; supplied oil company with data on petroleum possibilities in Alameda County and Sierran foothills; provided ownership information on oil field properties; assisted a cement company with location of their diamond drill holes, and with other features of their materials exploration programs; supplied a mining company with information sources of California diatomite; edited an article on "Mineral Wealth" for State Department of Education; assisted a consulting geologist on problems dealing with water supply for small towns in northwestern California; furnished an asbestos company with information on California chrysotile deposits and accompanied him on an inspection trip of one deposit; assisted a clay company with information on sources of pyrophyllite, nepheline syenite and china clay in California; assisted clay companies with information on sources of mica and clay; provided a steel company with information on swelling bentonite in California; assisted sand and clay com-

panies with information on clay and silica deposits; aided potential producer of lightweight aggregate in locating a source of raw material; discussed sources of chrome ore with a chrome mill operator.

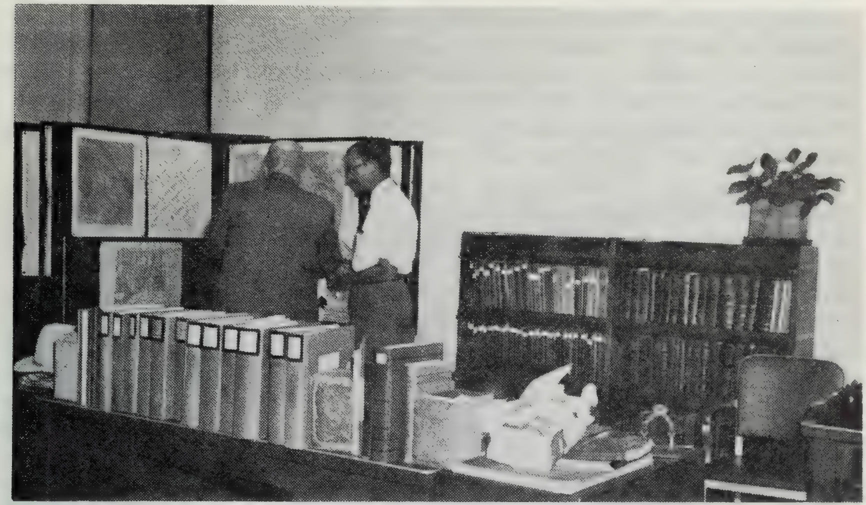

FIGURE 6. Public information section has geologist or engineer in attendance to assist persons wishing information on California mines or minerals.

(3) *Mineral Utilization and Marketing Data.* Examples of services rendered: Provided marketing data to industrial mineral producers representative; provided a clay company with data on volcanic cinders for ceramic use; provided prospective talc producer with information on market outlets; supplied data on bromine to firm expanding uses of this commodity; provided data on iron powder industry to a potential producer; supplied data on markets to owner of an asbestos deposit; furnished information on marketing ores and non-metallic minerals.

(4) *Physical and Chemical Data on Rocks and Minerals.* Examples of services rendered: Instructed a miner in methods of testing for chromium; helped a drilling concern locate an oil sand for use in testing equipment; referred chemist with titanium recovery process to owners and producers of titaniferous magnetite deposits; explained to prospectors the methods and equipment used in the location and recognition of minerals.

(5) *Production and Processing Data.* Examples of services rendered: Conferred with a zinc mine owner and suggested a line of action for development; examined an aggregate deposit for Division of Beaches and Parks and advised latter of applicable laws; assisted a clay company with information on magnetic separation of minerals in sand; provided a tungsten purchasing company with information on operating mines; discussed "colloidal gold" question with investors in a secret recovery process; obtained some cost data for prospective cyanide plant operation; supplied Water Pollution Control Board with mining information in southeastern California; supplied State Highway engineer with information on mining operations in California; provided data on marketing and processing manganese to potential producer;

obtained statistics on chrome production for economic survey by taxpayers association; supplied data on perlite processing to potential producer.

(6) *Handling Mining Documents.* Examples of services rendered: Assisted a claim owner in obtaining action on a patent application; explained to mining company representative the details and methods of locating a group of claims; assisted numerous claim owners in filling out location notices and affidavits of assessment work; answered numerous elementary questions on mining law; reviewed proposed mining lease agreements with lessors and lessees.

(7) *Itinerary Planning and Guiding.* Examples of services rendered: Conducted a gem and mineral society field trip to the Northern Mother Lode Country; conducted a hiking club on field trip in Mount Diablo area; conducted a geological society on field trip to Pinnacles National Monument; conducted a club on field trip in Marin and Sonoma Counties; conducted 200 geologists of Northern California Geological Society on trip through Capay Valley; led a geological society on field trip to Big Sur and Lime Kiln Creek; guided geologists of a Colorado mining company to potential nickel deposits in California; arranged visits to quarries and plants in Bay Area for representatives from Paraguay; guided an Illinois geology professor through the Alberhill clay area and assisted him in collecting clay samples; conducted a college group on trip through Death Valley mineral deposits.

(8) *Miscellaneous.* Examples of services rendered: Provided general information on lightweight aggregates, diatomite, dimension stone, clays, aggregates, glass sand, asbestos, manganese ore, quicksilver, chromite, and other commodities to interested parties; directed miners to operating properties where they found jobs; supplied information on specific commodities to press representative of San Francisco Chronicle, Sacramento Bee, New York Times, for use in feature articles; loaned photographs and supplied information on California mines and minerals to a dozen writers for local and national magazines; furnished a list of mines to numerous equipment sales companies and to truckers seeking haulage contracts.

MINERAL LABORATORY

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a laboratory in San Francisco for the purposes provided in this chapter."

During the 1953-54 fiscal year the laboratory of the Division of Mines reported upon 5,036 samples of minerals, ores, and rocks submitted by the public. This is an outstanding accomplishment, and represents an increase of 22 percent over the previous fiscal year, 1952-53.

This increase in the number of samples is largely due to increased interest among prospectors in fissionable materials—uranium and thorium, in strategic minerals—including tungsten, quicksilver, chromium, manganese, and the rare-earth elements, and greater demand in manufacturing for industrial minerals, especially the so-called nonmetallic materials.

During the fiscal year the Division's laboratory facilities were in constant use and were expanded to meet the requirements of the technical staff members. A high temperature furnace was installed to facilitate

studies on lightweight aggregates—expanded shale and perlite, calcination of limestones, and firing qualities of clays. The portable differential thermal analysis unit was used extensively in the preliminary examination of the expanded shale materials to identify the clay minerals present in the shales. A metallurgical polishing machine was also installed to prepare polished surfaces of metallic ore minerals, especially massive sulfides and lead-zinc minerals currently being investigated.

All microscopes were in almost constant use. The spectrograph was frequently used to determine trace elements, and to make qualitative determinations of particular samples under investigation by the staff.

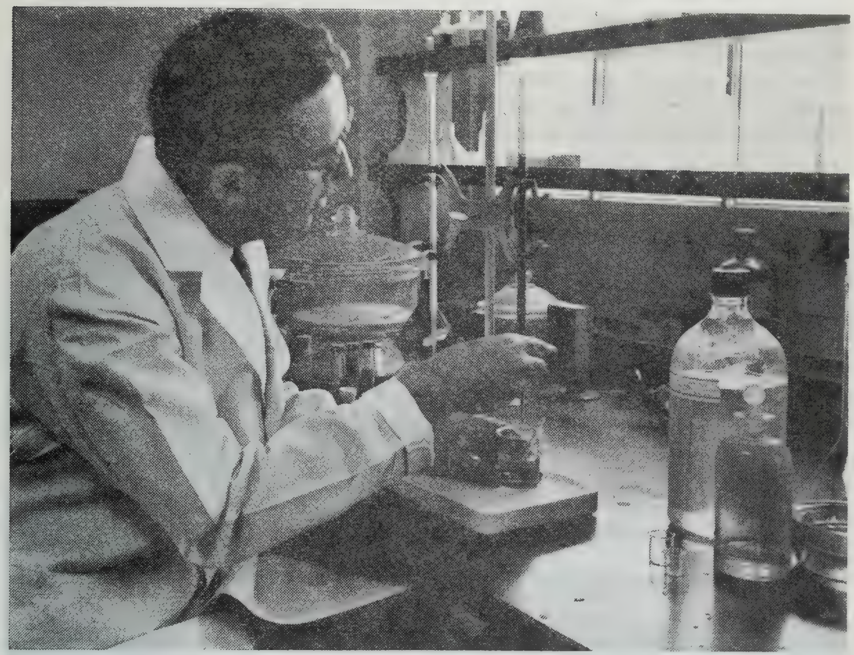

FIGURE 7. Division's mineral laboratory is equipped with basic laboratory materials, suitable for investigating chemical properties of rocks.

MINERAL EXHIBITS

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum . . . in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . .

(c) Make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes."

"2206. The State Mineralogist may prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the State."

In November 1953 the mineral exhibits of the Division of Mines were moved to the new and better lighted location on the east side of the second floor of the Ferry Building. During February and March 1954 the entire staff of the Division of Mines was engaged in setting up the

exhibits and arranging the minerals according to a plan to give maximum service to the public. This was a tremendous undertaking, a job which made use of the knowledge and fine cooperation of all technical staff members of the Division. A total of 5,227 mineral, rock and ore specimens was placed on exhibit, a job which required renumbering of the specimens, checking identifications, typing new identification cards, and arranging systematically the specimens in designated cases. As a result of this work in establishing well-planned exhibits, a marked increase in attendance was noted and many appreciative comments were received from visitors. Since the reopening of the exhibits to the public during May and June, 4,011 persons have inspected the collections. A large number of these visitors were school children who usually came in groups of 30 or more.

Ten new exhibit cases were received, but they were not delivered in time to be included in the initial job of exhibit work.

Late in the fiscal year a model of the Calaveras Cement Plant, constructed to scale and operative, was placed with the exhibits as an in-

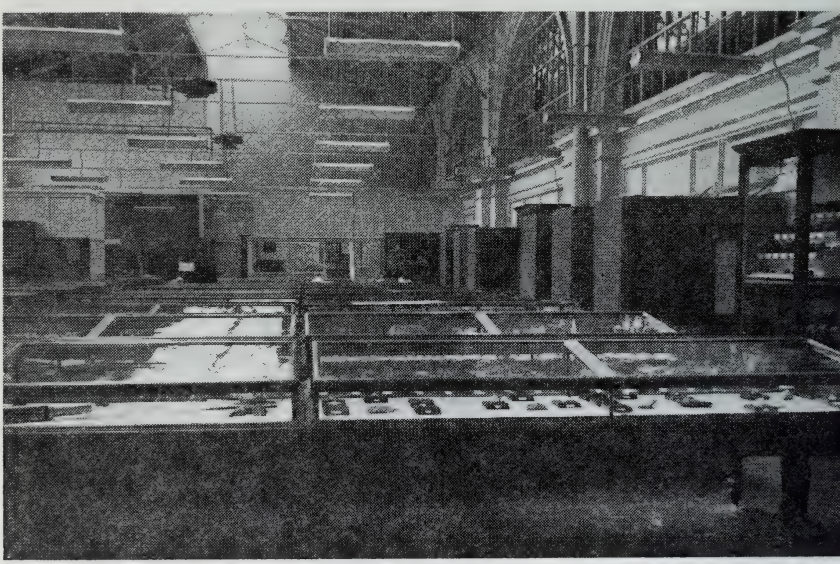

FIGURE 8. New Mineral Exhibit quarters house Division collection of rocks and minerals. One of the largest collections of its kind in the West, the exhibit features a systematically arranged group of minerals and significant displays of economically valuable ores and minerals.

definite loan. It has attracted much attention during its short stay and is a fine contribution to the plan of having industrial plants on exhibit to show the public how nonmetallic minerals are processed to make them useful to civilization.

The job of improving the various displays is continuing, new exhibit materials are constantly received and catalogued, and new exhibits of mineral commodities are being placed in the hallway adjacent to the Division's Library. One case, known as "Mineral of the Month," is changed each month to conform with the leading mineral commodity article in Mineral Information Service. It has attracted much interest.

A total of 167 sets of typical California rocks and minerals was provided on request to elementary schools in California. All requests for these sets, including the pending and current, were fulfilled.

MINERAL ACCESSIONS

Public Resources Code:

"2204. The State Mineralogist may receive on behalf of this State, for the use and benefit of the division, gifts, bequests, devices, and legacies of real or other property and may use the same in accordance with the wishes of the donors. If no instructions are given by the donors, the State Mineralogist shall manage, use, and dispose of the gifts, bequests, and legacies for the best interest of the division and in such manner as he may deem proper."

The following specimens were donated to the mineral exhibits of the Division of Mines during the 1953-54 fiscal year.

21525 Gold (Au), native gold, with quartz and mariposite. From Gold Crown Mining Corp., Gold Crown Mine, Alleghany, California. Donor: Fred and Dan Giles, 1953.

21526 Quartz (SiO_2), silicon dioxide, with hematite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21527 Quartz var. agate (SiO_2), silicon dioxide. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21528 Quartz var. amethyst (SiO_2), silicon dioxide. Contains heulandite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21529 Quartz var. amethyst (SiO_2), silicon dioxide. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21530 Quartz var. smoky (SiO_2), silicon dioxide, with hematite crystals. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21531 Quartz var. amethyst (SiO_2), silicon dioxide. White casts are presumably after natrolite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21532 Quartz var. agate (SiO_2), silicon dioxide. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21533 Quartz var. agate (SiO_2), silicon dioxide. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21534 Quartz (SiO_2), silicon dioxide. Herkimer diamonds in quartzite. From Middleville, New York. Donor: T. Orchard Lisle, 1953.

21535 Heulandite ($(Ca,Na,K)_6Al_{10}(Al,Si)Si_{29}O_{80}\cdot 25H_2O$), hydrous calcium, sodium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21536 Heulandite ($(Ca,Na,K)_6Al_{10}(Al,Si)Si_{29}O_{80}\cdot 25H_2O$), hydrous calcium, sodium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21537 Heulandite and laumontite ($(Ca,Na,K)_6Al_{10}(Al,Si)Si_{29}O_{80}\cdot 25H_2O$) and ($(Ca,Na)_7Al_{12}(Al,Si)_2Si_{26}O_{80}\cdot 25H_2O$), hydrous calcium, sodium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21538 Laumontite ($(Ca,Na)_7Al_{12}(Al,Si)_2Si_{26}O_{80}\cdot 25H_2O$), hydrous calcium, sodium, aluminum silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21539 Datolite ($(Ca_2B_2(SiO_4)_2(OH)_2)$), basic calcium borosilicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21540 Gmelinite ($mNa_{12}Si_{28}Al_{12}O_{80}\cdot 40H_2O + nNa_{10}Ca_2Si_{26}Al_{14}O_{80}\cdot 40H_2O$), hydrous calcium, sodium, aluminum silicate, with calcite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21541 Stilbite ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$), hydrous calcium, sodium, aluminum silicate, on casts of silica after natrolite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21542 Prehnite ($H_2Ca_2Al_2Si_3O_{12}$), calcium and aluminum silicate, on quartz crystals. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21543 Pectolite ($Ca_4Na_2Si_6O_{16}(OH)_2$), calcium and sodium basic silicate. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21544 Pectolite ($Ca_4Na_2Si_6O_{16}(OH)_2$), calcium and sodium basic silicate, with datolite on chabazite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1953.

21545 Magnetite (Fe_3O_4), iron oxide. Crystals showing dodecahedron and cube faces. From Gasquet, Del Norte County, California. Donor: C. R. Rice, 1953.

21546 Copper (Cu), native copper. From Isle Royal Lode, Houghton, Michigan. Donor: Martin L. Brite, 1953.

21547 Orpiment (As_2S_3), arsenic sulfide, with realgar. From Getchell Mine, Nevada. Donor: L. A. Norman, Jr., 1953.

21548 Orpiment (As_2S_3), arsenic sulfide, with realgar. From Getchell Mine, Nevada. Donor: L. A. Norman, Jr., 1953.

21549 Realgar (AsS) arsenic sulfide, in breccia. From Getchell Mine, Nevada. Donor: L. A. Norman, Jr., 1953.

21550 Silver ore (chloride and bromide of silver). Assays 1200 oz. silver per ton of ore. From Silurian Hills, San Bernardino County, California. Donor: L. A. Norman, Jr., 1953.

21551 Columbite ($(Fe,Mn)(Nb,Ta)_2O_6$), iron and manganese columbate-tantalate. Bladed crystals in feldspar with muscovite. From Globe Mine, Petaca, New Mexico. Donor: L. A. Norman, Jr., 1953.

21552 Columbite ($(Fe,Mn)(Nb,Ta)_2O_6$), iron and manganese columbite-tantalate. Feathered crystals in feldspar with green muscovite. From Globe Mine, Petaca, New Mexico. Donor: L. A. Norman, Jr., 1953.

21553 Samarskite (complex oxide of niobium, tantalum, and the cerium metals), with allanite, quartz, and feldspar. From Mojave County, Arizona. Donor: L. A. Norman, Jr., 1953.

21554 Monazite and columbite ($(Ce,La,Y,Th)(PO_4)$), phosphate of the cerium metals and ($(Fe,Mn(Nb,Ta)_2O_6$), iron and manganese columbate-tantalate, in feldspar with muscovite. From Globe Mine, Petaca, New Mexico. Donor: L. A. Norman, Jr., 1953.

21555 Monazite ($(Ce,La,Y,Th)(PO_4)$), phosphate of the cerium metals. Crystals in bladed columbite with feldspar. From Globe Mine, Petaca, New Mexico. Donor: L. A. Norman, Jr., 1953.

21556 Garnierite ($H_2(Ni,Mg)(SiO_4)$), hydrous nickel, magnesium silicate, in altered serpentine. From near Democrat, North Carolina. Donor: L. A. Norman, Jr., 1953.

21557 Muscovite ($(H,K)AlSiO_4$), potassium, aluminum silicate. Pink crystals with quartz and feldspar. From Globe Mine, Petaca, New Mexico. Donor: L. A. Norman, Jr., 1953.

21558 Spodumene ($LiAl(SiO_3)_2$), lithium, aluminum silicate. Part of a single crystal. From Harding Mine, Taos County, New Mexico. Donor: L. A. Norman, Jr., 1953.

21559 Columbite-tantalite ($(Fe,Mn)(Nb,Ta)_2O_6$), iron and manganese columbate-tantalate. Placer nuggets. From Petaca Mining District, Rio Arriba County, New Mexico. Donor: Glen V. Slater, 1953.

LIBRARY

Public Resources Code:

"2205. The State Mineralogist shall: . . .

(d) Provide a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the library of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes.

(f) Preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours.

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State to consist of such collections and library, and arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it."

The following summary report by the librarian shows the activities and services provided by the Division of Mines library:

Service	*1952-53*	*1953-54*	*Approximate increase or decrease*
Books and maps used by visitors	4,094	5,410	+34%
Books and maps used by staff members	4,394	3,067	—30%
Exchange mailing list—added	18	15	—16%
Library mailing list	153	89	—40%*
Publications issued by stock order	2,443	2,997	+25%
School library kits distributed	167	181	+9%
Film loans	19	34	+75%
Interlibrary loans:			
Publications loaned out } Publications received on loan }	59	31	—50%

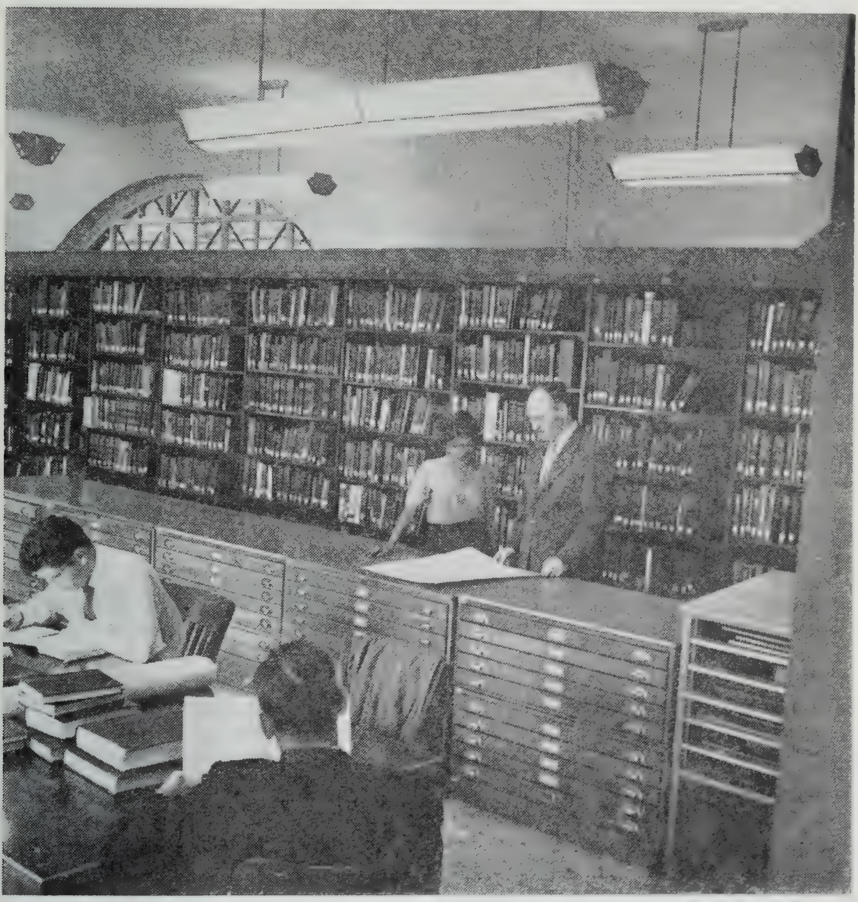

FIGURE 9. Division of Mines Library, now housed in new quarters in north end of Ferry Building, has several thousand technical books on its shelves. Professional staff Librarian assists staff and public with research and bibliographic problems.

Figures showing increased use of library materials (books and maps) by the public do not include comparative figures for use of current periodicals for the period from Nov. 1, 1953. An estimated 75% increase in the number of people using the periodical reading room has been noted in this period.

Receipts

Classed books:	*1952-53*	*1953-54*	
Purchase	213	190	
Exchange	67	80	
Donation (including purchases from gift funds)	64	115	
Duplicate exchange	42	---	
Total	386	385	
Number of classified books at end of fiscal year	9,231	9,616	
Periodicals:			
San Francisco library subscriptions	56	69	
Branch office subscriptions	14	15	
Received on exchange	140	245	
Total	210	329	+56%
Maps and charts	747	1,208	+60%

Exchange Program. Extension of the exchange program continues to broaden the Library's resources relating to world-wide developments in geology and mining. Proposals for exchanges from newly established geological surveys in Northern Ireland, Fiji Colony, and Jamaica and from institutions in Japan, South Africa, Australia, and Yugoslavia, attest to the interest in Division of Mines' publications internationally. Added to the exchange list in this country were universities in Idaho, Indiana, Louisiana, and Oregon.

Public Relations.

Libraries and schools visited	144	67	—50% *
Conservation conferences, teachers institutes and college classes	---	4	

* Public relations activities—school and library visits and number of additions to library mailing list—show reduction because of the time taken up by planning the new quarters and preparations for moving the library.

Much of the present day awareness of the problems of conservation of natural resources may be credited to the new emphasis on conservation studies in the schools. The Division of Mines contributes to the public knowledge of our mineral resources by making reports and studies available to county and municipal libraries as well as to school and college and teachers professional libraries throughout the State. During the year the librarian continued visiting schools to present Division of Mines materials and to discuss their use in conservation studies with supervisors, librarians, and curriculum directors.

The book, *Conservation—Concern for Tomorrow,* issued this year by the State Department of Education has a chapter titled Our Mineral Wealth contributed by the Division of Mines.

The figures showing increased service to the public reflect appreciation of the enlarged and improved library quarters resulting from the move to the south wing of the Ferry Building. Convenience and

accessibility of the collections and facilities not possible in the former location have been achieved by an arrangement of the stacks leaving an open, uncrowded reading area. A periodical reading room area has been provided at one end of the stacks with specially constructed shelves for display of current magazines.

FIGURE 10. New quarters of Periodical room are more convenient to public and staff than former quarters. Periodical room increased greatly in usage in fiscal year 1953-54.

BOOKS ADDED TO LIBRARY DURING FISCAL YEAR 1953-54

Ahlmann, Hans W. Glacier variations and climatic fluctuations. New York, American Geographical Society, 1953.

American Association of Petroleum Geologists. AAPG, SEPM, SEG guidebook; field trip routes, oil fields, geology. Joint annual meetings, Houston, Texas, March 1953.

American Association of Petroleum Geologists. Directory of films and slides of possible interest to geologists. 2d ed. Tulsa, 1951.

American Bureau of Metal Statistics. Yearbook, 1953. New York, 1954.

American Chemical Society. Sixth annual review of analytical chemistry. Washington, 1954.

American Geophysical Union. Annotated bibliography on hydrology, 1941-1950, United States and Canada. Washington, Government Printing Office, 1952.

The American peoples encyclopedia yearbook; events and personalities of 1952. Chicago, 1953.

The American peoples encyclopedia yearbook; events and personalities of 1953. Chicago, 1954.

American Society for Metals. Zirconium and zirconium alloys. A symposium. Cleveland, 1953.

American Society for Testing Materials. Book of ASTM standards. 1952. Parts 1, 2, 3, 5. Philadelphia, 1953.

American Society for Testing Materials. Symposium on light microscopy. 1953.

American Society for Testing Materials. Symposium on porcelain enamels. 1953.

American Society for Testing Materials. Symposium on surface and subsurface reconnaissance. 1952.

American Society for Testing Materials. Symposium on use of pozzolanic materials in mortars and concretes. 1953.

Annual review of nuclear science. Vols. 2 and 3. 1953. Stanford, Calif., Annual Reviews.

Arkel, Anton E. van. Molecules and crystals in inorganic chemistry. London, Butterworths Scientific Publications, 1949.

Asbestos Textile Institute. Handbook of asbestos textiles. New Brunswick, N. J., 1952.

Battelle Memorial Institute. Fifty year bibliography of titanium 1900-1951. Supplement 1952. Columbus, Ohio, 1952, 1953.

Berkeley. City Planning Commission. Preliminary master plan for Berkeley. 1953.

Beuschlein, Muriel. Free and inexpensive materials for conservation education. Chicago, 1953.

Bonorino, Felix G. Lexico sedimentologico. Buenos Aires, Institute Nacional de Investigacion de las Ciencias Naturales, 1952.

Bragg, William H. The Crystalline state. London, G. Bell, 1933. Reprinted with corrections, 1949.

British Ceramic Society. Ceramics; a symposium. Stoke-on-Trent, 1953.

Brown, Harrison S. A bibliography on meteorites. Chicago, University of Chicago Press, 1953.

Buchwald, Eberhard. Einführung in die Kristalloptik. 4th ed. Berlin. Walter de Gruyter, 1952.

Butts, Allison, ed. Copper; the science and technology of the metal, its alloys and compounds. ACS Monograph Series No. 122. Reinhold, 1954.

California. University. Publications in Geological Sciences.
 Williams, Howell. Volcanic history of the Meseta Central Occidental. Vol. 29, no. 4. 1952.
 Higgins, Charles G. Lower course of the Russian River. Vol. 29, no. 5. 1952.
 Stirton, R. A. A new genus of interatheres from the Miocene of Columbia. Vol. 29, no. 6. 1953.
 Langston, Wann. Permian amphibians from New Mexico. Vol. 29, no. 7. 1952.
 Briggs, Louis I. Upper Cretaceous sandstones of Diablo Range, California. Vol. 29, no. 8. 1953.

California almanac and State fact book. 1953-54. Los Angeles.

Chapin, Edward L. A selected bibliography of southern California maps. Berkeley, University of California Press, 1953.

Clark, Lewis W. Trail guide to the high Sierra camp areas, Yosemite National Park. Stanford University Press, 1953.

Cloos, Hans. Conversation with the earth. New York, Knopf, 1953.

Collison, Robert L. Indexes and indexing; a guide to the indexing of books, and collections of books, periodicals, music, gramophone records, films, and other material. New York, J. De Graff, 1953.

Colorado School of Mines. Quarterly.
 Le Maire, George W. A study of asphalts and asphaltic shale. Vol. 48, no. 2. 1953.
 Current, A. M. A review of the geology and activities in the Uinta Basin. Vol. 48, no. 3. 1953.
 Mackay, Ian H. Geology of the Thomasville-Woods Lake area, Eagle and Pitkin Counties, Colorado. Vol. 48, no. 4. 1953.
 Reichert, Stanley O. Geology of the Golden-Green Mountain area, Jefferson County, Colorado. Vol. 49, no. 1. 1954.

Columbia University. School of Library Service. The subject analysis of library materials. New York, 1953.

Commodity year book, 1953. New York, Commodity Research Bureau, 1953.

Conference on soil stabilization. Proceedings. Cambridge, Massachusetts Institute of Technology, 1952.

Conservation Committee of California Oil Producers. Annual review of California crude oil production, 1953. Los Angeles, 1954.

Cooper, Margaret. Bibliography and index of literature of uranium and thorium and radioactive occurrences in the United States. Reprinted from Geological Society of America Bulletin. New York, 1953-54.

Corby, Grant W. Geology and oil possibilities of the Philippines. Manila, 1951.

Cumulative Book Index, 1949-1952. New York, H. W. Wilson, 1953.

Dake, Henry C. California gem trails; a field guide for the gem hunter, the gem cutter, and the mineral collector. 2d ed. Portland, Mineralogist, 1952.

Duke, C. Martin, ed. Proceedings of the symposium on earthquake and blast effects on structures, Los Angeles, June 1952. Berkeley, Earthquake Engineering Research Institute, 1952.

Dunham, K. C. Fluorspar. Memoirs of the Geological Survey. Special reports on the mineral resources of Great Britain. Vol. 4. London, H.M. Stationery Office, 1952.

Eardley, Armand J. Aerial photographs; their use and interpretation. New York, Harper, 1942.

Eitel, Wilhelm. The physical chemistry of the silicates. Chicago, University of Chicago Press, 1954.

Ely, Sims. The Lost Dutchman mine. New York, Morrow, 1953.

The Engineering Index. 1953. New York, 1954.

Engle, H. M. Recommendations: earthquake resistant design of buildings, structures and tank towers. San Francisco, Pacific Fire Rating Bureau, 1950.

Eskew, Garnett L. Salt, the fifth element; the story of a basic American industry. Chicago, J. G. Ferguson, 1948.

Eyles, V. A. The composition and origin of the Antrim laterites and bauxites. Memoir of the Geological Society of Northern Ireland. Belfast, 1952.

FBI Register of British manufacturers. 26th ed. London, Federation of British Industries, 1954.

Fanning, Leonard M. The rise of American oil. Rev. ed. New York, Harper, 1948.

Fears, Fulton K. Bibliography on mineral aggregates, annotated. Highway Research Board, 1949.

Fenton, Carroll L. Riches from the earth. New York, J. Day Co., 1953.

Forbes, Robert J. Metallurgy in antiquity; a notebook for archaeologists and technologists. Leiden, E. J. Brill, 1950.

Friend, John A. N. Man and the chemical elements, from stone-age hearth to the cyclotron. New York, Scribner, 1953.

Geological Society of America. Memoirs.

Cooper, Byron N. Trilobites from the lower Champlainian formations of the Appalachian Valley. (55) 1953.

Williams, Alwyn. North American and European stropheodontids. (56) 1953.

Camp, C. L. Bibliography of fossil vertebrates, 1944-1948. (57) 1953.

Newell, Norman D. Upper Paleozoic of Peru. (58) 1953.

Whittington, H. B., and Evitt, W. R. Silicified Middle Ordovician trilobites. (59) 1954.

Donnay, J. D. H. Crystal data. (60) 1954.

McKee, Edwin D. Stratigraphy and history of the Moenkopi formation of Triassic age. (61) 1954.

Grim, Ralph E. Clay mineralogy. New York, McGraw-Hill, 1953.

Gubelin, Edward J. Inclusions as a means of gemstone identification. Los Angeles, Gemological Institute of America, 1953.

Gutkind, E. A. Our world from the air; an international survey of man and his environment. Garden City, N. Y., Doubleday, 1952.

Haddock, Marshall H. Disrupted strata; faulting and its allied problems from the standpoint of the mine surveyor and stratigraphist. New York, Anglo-books, 1954.

Hawkins, Reginald R., ed. Scientific, medical, and technical books published in the United States of America; a selected list of titles in print with annotations. Second supplement, books published 1949-1952. Washington, National Research Council, 1953.

Hayward, Carle R. An outline of metallurgical practice. 3d ed. New York, Van Nostrand, 1952.

Henderson, J. G. Metallurgical dictionary. New York, Reinhold, 1953.

Henderson, P. L. Brown coal, its mining and utilization. Melbourne University Press, 1953.

Hendrix, Charles E. The cave book. Revere, Mass., Earth Science Publishing Co., 1950.

Highway Research Board. Engineering soil survey mapping. 1951.

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Highway Research Board. Mapping and subsurface exploration for engineering purposes. 1952.

Highway Research Board. A selected list of references on aerial surveying and mapping, 1929-1949.

Highway Research Board. Soil exploration and mapping. 1950.

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Hopkins, D. M. Geological background of the Iyatayet archeological site, Cape Denbigh, Alaska. Washington, Smithsonian Institution, 1953.

Hoyos de Castro, Angel. Genesis de la arcilla. Madrid, 1949.

The Institution of Metallurgists. The metallurgy of the rarer metals. London, 1953.

Institution of Mining and Metallurgy. Recent developments in mineral dressing. A symposium. London, 1953.

Intermountain Association of Petroleum Geologists. Guide to the geology of northern Utah and southeastern Idaho. Fourth annual field conference, 1953.

International Geological Congress. 19th, Algiers, 1952.
La Géologie et les problemes de L'eau en Algerie.
Liste des gélogues du monde. 1952.
Monographies régionales. 1st series Algeria. 2nd series: Tunisia. 3rd series: Morocco. 1952.
Symposium sur les gisements de fer du monde. 2 v. and atlas. 1952.
Symposium sur les series de Gondwana. 1952.

International Geological Congress. 19th, Algiers, 1952. Comptes rendus.
1. Les subdivisions et les corrélations de L'Antécambrien. 1953.
2. Le Paleozoïque nord-africain et ses corrélations avec celui des autres régions du monde. 1953.
3. Mécanique de la déformation des roches. 1953.
4. Topographie sous-marine et sédimentation actuelle. 1953.
5. Catalogue des hommes fossiles. 1953.
8. L'hydrogéologie des regions ardes et sub-arides. 1953.
11. Origine des gisements de phosphates de chaux. 1953.
18. Comité international pour l'étude des argiles. 1953.

James, Marquis. The Texaco Story; the first fifty years, 1902-1952. Written for the Texas Company. New York, 1953.

Jeffreys, Harold. The earth, its origin, history, and physical constitution. 3d ed. Cambridge (Eng.) University Press, 1952.

Jensen, David E. Mineral collector's guide. Rochester, Wards Natural Science Establishment, 1953.

Johns-Manville Corporation. Celite; the story of diatomite. New York, 1953.

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Le Gear. United States atlases. Vol. 1. Washington, Library of Congress, 1950.

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Liquid-metals handbook. 2d ed. Washington, Government Printing Office. 1952.

Longwell, Chester R., ed. Bowen volume. New Haven, American Journal of Science, 1952.

McKee, Edwin D. Studies of stratification in modern sediments and in laboratory experiments. Tucson, Arizona Geological Society, 1953.

McNair, James B. With rod and transit; the engineering career of Thomas S. McNair, 1824-1901. Los Angeles, 1951.

Martin, Louis C. Practical microscopy. 2d ed. Brooklyn, Chemical Publishing Company, 1951.

Mathewson, Champion H., ed. Modern uses of non ferrous metals. 2d ed. New York, American Institute of Mining and Metallurgical Engineers, 1953.

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Miller, Henry. Account of a tour of the California missions, 1856. The journal and drawings of Henry Miller. San Francisco, The Book Club of California, 1952.

Mitchell, John D. Lost mines and buried treasures. Palm Desert, California, Desert Press, 1953.

Moore, L. R. Geology and man. University of Sheffield, Inaugural Lecture, 1950.

Morey, George. The properties of glass. 2d ed. ACS Monograph Series No. 124. Reinhold, 1954.

Morgan, Dale L. Jedediah Smith and the opening of the West. Indianapolis, Bobbs-Merrill, 1953.

Munger Oilogram. Annual report, 1953. Los Angeles, 1953.

National Research Council. Report of the Committee on the measurement of geologic time. 1951-1952. Washington, 1953.

Newell, Norman D. The Permian reef complex of the Guadalupe Mountains region, Texas and New Mexico; a study in paleontology. San Francisco, W. H. Freeman, 1953.

Newhall, Nancy. Death Valley. Photographs by Ansel Adams. San Francisco, Five Associates, 1954.

Niggli, Paul. Rocks and mineral deposits. San Francisco, W. H. Freeman, 1954.

Northern California Geological Society. Syllabus, Capay Valley—Wilbur Springs trip. San Francisco, 1954.

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PUBLIC APPEARANCES

Frequently a member of the Division of Mines is requested to appear before a public gathering to give an address on the geology or mineral resources of California, to conduct a field trip through an area of particular interest, to show technical motion pictures from the Division's film library, or to provide publications for display and sale. During the 1953-54 fiscal year, members of the staff attended and participated in a total of 170 meetings, conferences, fairs and mineral shows. Thirty-one talks were given; several symposiums and panel discussions were presented, and eight separate field trips were conducted. Display of Division of Mines publications was requested at meetings of technical societies, fairs, and mineral shows; during fourteen of these, publications were sold to the amount of $2,064.87. The following list indicates the type and variety of public appearances during the year.

Technical and advisory

American Association of Petroleum Geologists—Presented papers, sold publications, published syllabus and led field trip.
American Ceramic Society—Participated in program committee and presented papers at Sixth Pacific Coast Regional Conference.
American Institute of Mining and Metallurgical Engineers—Attended technical sessions in New York and local section meetings.
American Mining Congress
Association of American State Geologists—Served as secretary-treasurer.
California Hydraulic Mining Association—Presented seven programs.
Idaho Mining Association
Los Angeles Chamber of Commerce Mining Committee—Talks given; presented symposium on industrial minerals.
Mining Association of the Southwest—Talk given.
Pacific Coast Regional Conference on Clays and Clay Technology—Helped organize two-day meetings.
San Francisco Chamber of Commerce Mining Committee—Presented symposium on industrial minerals.
Society of Economic Paleontologists and Mineralogists
U. S. Bureau of Mines conference for clay workers—Presented paper.
University of California Clay Committee
Western Mining Council.

Fairs and mineral shows

Benicia Gem and Mineral Show
California State Fair—Model mine exhibit; judged mining and mineral exhibits.
Castro Valley Mineral Show
Los Angeles County Fair
Monterey Mineral Society Show
Orange Gem and Mineral Show
Sacramento Mineral Society Show
San Bernardino County Fair—Represented at opening ceremonies.
San Francisco Gem and Mineral Fair
San Joaquin Valley Gem and Mineral Show
San Luis Obispo Mineral Show
San Mateo County Gem and Mineral Show
Santa Rosa Mineral Show
Sonoma County Fair
Stockton Mineral Show
Victorville Fair

Representatives were in continuous attendance throughout the above fairs and shows, exhibiting mineral specimens, selling publications, identifying minerals, and giving information on minerals and mining.

Mineral and geological societies

Castro Valley Gem and Mineral Society—Talk given, conducted field trip.
Contra Costa Mineral Society—Talk given.
East Bay Mineral Society—Talk given; presented symposium on mineral and rock identification.
Geological Society of Sacramento—Talk given
Konocti Rock Club of Lakeport—Talk given
LeConte Club
Marin Gem and Mineral Society—Talk given
Monterey Bay Mineral Society—Talk given
Mother Lode Mineral Society—Talks given (2)
Napa Rock and Gem Club—Illustrated talk given
National Convention of Federation of Gem and Mineral Societies
Northern California Geological Society
Pacific Mineral Society
Palo Alto Geology Society—Talk given; led three field trips
San Francisco Mineral Society—Talk given

Educational

Association of Geology Teachers meeting to organize Far Western Section
Missouri and Montana School of Mines Alumni joint meeting—Showed motion picture
Northern California Science Teachers Exhibition in Sacramento—Displayed Division of Mines educational materials.
Notre Dame High School—Illustrated talk given.
Palo Alto High School adult education class—Talk given
Placer Junior College—Lecture to Sierra mineral group.
San Francisco City College geology class—Led 4-day field trips in Death Valley.
San Francisco State College—Guided students through museum and laboratory.
San Jose State College conservation class—Talk given; film shown.
Sierra College—Talk given.
University of California at Los Angeles, geology staff and students—Presented panel discussion.

Miscellaneous

American Society of Architectural Historians—Talk given
Annual Economic Conference of Boards of Trade and industrial representatives of Riverside and San Bernardino Counties—Talk given
Contra Costa Hills Club—Led field trip
General Petroleum Corporation—Illustrated talk given.
Kiwanis Club—Talk given
Montclair Church adult class—Film shown.
Naval Reserve group—Talk given.
Norelco X-ray Diffraction School
Old Time Miners Celebration at Randsburg
Sierra Club Natural Science Section—Led geological and mining field trip.
Southern California Gas Company Rod and Gun Club—Talk given
Southern California Stone Dealers Association—Contributed to discussion of stone resources and marketing problems.
Walnut Creek church group—Talk given.
Talks were given on the following subjects:
Mineral resources of specific areas of the state.
Rocks and minerals of California—origin, occurrence and identification.
Clay, aggregates, coal and obsidian
Strategic minerals of California.
Clay industry in California
Tungsten resources of California
Methods of prospecting for minerals in California
Current mining activities in California
California earthquakes
Jade in California
Volcanic glasses in California
Serpentine in California
Topographic maps

Limestone
Geology of petroleum
Reconnaissance geology of California coastal area north of Eureka
Pre-Christian era of recovery of placer gold
Trends of California mineral industry
Geologic history of Bay area
Pegmatites
Geology along California highways
Rhyolite tuff structures in the California Mother Lode
From prospect to mine
Silver

PUBLICATIONS

Public Resources Code:

"2205. The State Mineralogist shall: . . . (h) Issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state."

"2209. The State Mineralogist may fix a price upon and dispose of to the public all publications of the division, including reports, bulletins, maps, registers, or other publications. The price shall approximate the cost of publication and distribution. He may also furnish the publications of the division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies."

"2210. All money received by the division from sales of publications issued by the division shall be deposited at least once each month in the State Treasury to the credit of the General Fund. . . ."

Four types of publications are issued by the Division of Mines. All except *Mineral Information Service* (sent gratis) are sold to the public at cost of printing. During fiscal 1953-54, $36,671.23 was received from sales of publications. In the previous fiscal year, the total sales were $22,626.84. This 62 percent increase in publication sales was partly due to the demand by educational institutions for Bulletin 158, *Evolution of the California landscape.*

(1) *Mineral Information Service.* Monthly ($8\frac{1}{2}'' \times 11''$) offset press pamphlet, distributed without cost upon request. This has been issued since February 1948.

Through this medium, current information and news of mineral developments are given, statistics and market figures are recorded without delay, announcement of new publications permits wider distribution of results of surveys, and a regular mineral commodity study of great interest to the public is reported. New industries have actually been initiated by this service. By the end of fiscal 1953-54, 25,000 copies were being printed each month, of which over 19,000 were sent to the regular mailing list and the remaining 6,000 were distributed from the information counters, at meetings, and in answer to many written and oral questions. In spite of the annual circularization which resulted in dropping nearly 2,000 subscribers who did not return cards, the list has increased 19 percent over the previous fiscal year.

(2) *California Journal of Mines and Geology.* This is a continuation of the earlier *Report of the State Mineralogist* started in 1880. Quarterly periodical (paper covered, $6'' \times 9''$) sold separately ($1.00) or by annual subscription ($3.00). Through the medium of the Journal, an inventory of the mines of the state is recorded. County reports on the mines and mineral resources, reports on mineral utilization surveys, final statistical figures, and the annual report of the State Mineralogist are published in the Journal. Each county report is accompanied by a tabulated list of mining properties which is coordinated

FIGURE 11. Stockroom of the Division has been moved to south end of building, slip level. Major tasks of stockroom staff include storage, inventory, wrapping and mailing of publications.

with a mineral map. In this manner the Division maintains a directory of all mines and significant properties of California.

(3) *Bulletins.* Published at irregular intervals (generally cloth covered, standard format 6″ x 9″, but other sizes also used); cover state-wide surveys, broad-subject monographs, and quadrangle geologic surveys; sold at cost of printing. The bulletin most recently published is No. 168.

(4) *Special Reports.* A new series (paper covered, $8\frac{1}{2}$″ x 11″), started in December, 1950, covering subjects of special concern, but not of state-wide scope or of as broad scope as the Bulletin. The last Special Report issued is No. 39.

Through the medium of the Special Report the results of units of research are available without much delay. The $8\frac{1}{2}$″ x 11″ page provides more room for tables, photographs, and maps than the standard Journal and Bulletin 6″ x 9″ page. The Special Report is becoming increasingly popular, and has relieved the overloading of the Journal with highly technical reports.

The following list gives the titles of all publications of the Division of Mines for fiscal 1953-54; it is divided into two parts as follows:

(1) Publications issued during fiscal 1953-54 (actually distributed to the public).

(2) Publications in press at close of fiscal 1953-54 (not ready for distribution on June 30, 1954, but in process of publication).

PUBLICATIONS ISSUED DURING FISCAL YEAR 1953-54

As the authorship of reports is not limited to the staff of the Division of Mines, the affiliation of each author is shown by the following symbols:

SDM Member of State Division of Mines
GS Member of U. S. Geological Survey
U Member of a university faculty or student body
C Consultant or member of commercial firm

Mineral Information Service

Vol. 6, No. 7: Volcanic rocks (SDM); Price list of available publications of the California State Division of Mines (SDM); Perlite processing plants in the Los Angeles area (SDM).

No. 8: New book tells origin of California's landscape (SDM); Equipment for small-scale gold placer mining (SDM); Mine production of gold, silver, copper, lead, and zinc in California in 1952 in terms of recoverable metal (SDM).

No. 9: Lithium compounds (SDM); California's lithium gems (SDM).

No. 10: Clay in Los Angeles County (SDM); Newly opened clay deposit, by George Lunetta (C); Mineral production in California in 1951 by counties (SDM); Ceramic kilns (SDM).

No. 11: Diatomite, by P. W. Leppla (C); California diatomite operations in 1952 (SDM).

No. 12: Manganese in California (SDM).

Vol. 7, No. 1: Petroleum in California (SDM); Index to oil and gas field maps (SDM); Consolidated index to Mineral Information Service, volumes 1-6 (SDM); Chronicle of quicksilver (SDM).

No. 2: Salt (SDM); Gold, silver, copper, lead and zinc in 1953 (SDM).

No. 3: Fluorescence of minerals (SDM); Manganese mining in southern California (SDM); Stone quarries (SDM).

No. 4: Mica (SDM); Production and utilization of California petroleum in 1953 (SDM); Early oil mining in California (SDM).

No. 5: Landslides in Ventura Avenue oil field (SDM); Crude oil reserves in the United States (SDM); Defense minerals program (SDM).

No. 6: Glass sand in California (SDM); Flotation of Del Monte sand, by William E. Messner (C); California counties in order of total of recorded mineral production to and including 1951 (SDM).

California Journal of Mines and Geology

Vol. 49, No. 3: July, 1953: Flotative properties of titanium minerals in oleate solutions, by V. S. Pradhan (U) and D. W. Mitchell (U): Mines and mineral resources of Kings County, California, by Charles W. Jennings (SDM); Adsorbent clays in California, by Richard S. Lamar (C).

No. 4: October 1953: Mines and mineral resources of Mendocino County, California, by J. C. O'Brien (SDM); Supplement, De Argento Vivo, by Elisabeth L. Egenhoff (SDM); Index to volume 49 (SDM).

Vol. 50, No. 1: Annual report of the State Mineralogist, Chief of the Division of Mines, for the 104th fiscal year, July 1, 1952 to June 30, 1953, by Olaf P. Jenkins (SDM); California mineral commodities in 1951, by Henry H. Symons (SDM) and Fenelon F. Davis (SDM); Mines and mineral resources of Amador County, California, by Denton W. Carlson (SDM) and William B. Clark (SDM).

No. 2: Nineteenth century mines and mineral spring resorts of Lake County, California, by Frederick J. Simoons (U); Mines and mineral resources of Santa Clara County, California, by Fenelon F. Davis (SDM) and Charles W. Jennings (SDM).

Bulletins

134. Part II, Chapter 2, Chromite deposits of the southern Coast Ranges of California, by George W. Walker (GS) and A. B. Griggs (GS).
134. Part III, Chapter 5, Chromite deposits in the northern Sierra Nevada, California (Placer, Nevada, Sierra, Yuba, Butte, and Plumas Counties), by Garn A. Rynearson (GS).
164. Geology of Eel River Valley area, Humboldt County, California, by Burdette A. Ogle (U).
166. Geology of Lower Lake quadrangle, California, by James C. Brice (U).
167. Geology of the Ortigalita Peak quadrangle, California, by Louis I. Briggs Jr. (U).
168. Geology of the Breckenridge Mountain quadrangle, California, by T. W. Dibblee Jr. (C) and Charles W. Chesterman (SDM).
170. Geology of southern California. Chapter V, Geomorphology: Some physiographic aspects of southern California, by Robert P. Sharp (U); Geomorphic processes in the desert, by Eliot Blackwelder (U); Physiographic features of faulting in southern California, by Robert P. Sharp (U); Beach and nearshore processes along the southern California coast, by Douglas L. Inman (U); Pleistocene lakes and drainage in the Mojave region, southern California, by Eliot Blackwelder (U); Pleistocene glaciation in the upper San Joaquin basin, Sierra Nevada, by Joseph H. Birman (U); Marine terraces of the Ventura region and the Santa Monica Mountains, California, by William C. Putnam (U); The nature of Cima Dome, by Robert P. Sharp (U); History of the lower Colorado River and the Imperial depression, by Chester R. Longwell (U).

Special Reports

31. Geology of the Johnston Grade area, San Bernardino Mountains, California, by Robert B. Guillou (U).
32. Geological investigations of strontium deposits in southern California, by Cordell Durrell (GS).
33. Geology of the Griffith Park area, Los Angeles County, California, by George J. Neuerburg (U).
34. Geology of the Santa Rosa lead mine, Inyo County, California, by Edward M. Mackevett (GS).
35. Tungsten deposits of Madera, Fresno, and Tulare Counties, California, by Konrad B. Krauskopf (GS).
36. Geology of the Palen Mountains gypsum deposit, Riverside County, California, by Richard A. Hoppin (U).
37. Rosamond uranium prospect, Kern County, California, by George W. Walker (GS).
39. Barite deposits near Barstow, San Bernardino County, California, by Cordell Durrell (GS).

Reprints

Bulletin 141. Geologic guidebook along Highway 49—Sierran gold belt: Sierran roads of today and yesterday, by Dorothy G. Jenkins (C); The discovery of gold in California, by Donald C. Cutter (U); History of placer mining for gold in California, by Charles V. Averill (SDM); Sierra Nevada province, by Olaf P. Jenkins (SDM); Geologic history of the Sierran gold belt, by Olaf P. Jenkins (SDM); History of mining and milling methods in California, by C. A. Logan (SDM); Geologic maps and notes along Highway 49, by Oliver E. Bowen Jr. (SDM) and Richard A. Crippen Jr. (SDM); The formation of quartz veins, by John A. Burgess (C); Mining on Carson Hill, by John A. Burgess (C); Survey of building structures of the Sierran gold belt, 1848-70, by Robert F. Heizer (U) and Franklin Fenenga (U)

The elephant as they saw it, by Elisabeth L. Egenhoff (SDM)

Legal guide for California prospectors and miners, compiled under the direction of L. A. Norman Jr. (SDM)

Publications of the California State Division of Mines to October 1, 1953 (SDM)

PUBLICATIONS IN PRESS AT CLOSE OF FISCAL YEAR 1953-54

Mineral Information Service

Vol. 7, No. 7: Uranium (SDM); Table of common uranium minerals (SDM)

No. 8: California mineral production in 1952 (SDM); Value of mineral output in California for 1952 by counties (SDM); Price list of available publications of the California State Division of Mines (SDM)

California Journal of Mines and Geology

Vol. 50, No. 3: Mines and mineral resources of Los Angeles County, by Thomas E. Gay Jr. (SDM) and Samuel R. Hoffman (SDM); The Cool-Cave Valley limestone, El Dorado and Placer Counties, California, by William B. Clark (SDM); Annual report of the State Mineralogist, Chief of the Division of Mines for the 105th fiscal year . . . , by Olaf P. Jenkins (SDM); Index to volume 50.

Bulletins

165. Geology of the Barstow quadrangle, California, by Oliver E. Bowen Jr. (SDM)
169. Clays and clay technology, ed. by Joseph Pask (U) and Mort D. Turner (SDM): INTRODUCTION—Objectives of the first national conference on clays and clay technology, and definition of terms used in the industry, by Ralph E. Grim (U); PART I—Formation and occurrence of clay minerals, by Paul F. Kerr (U); Structural mineralogy of clays, by George W. Brindley (U); PART II—Electrochemical properties of clays, by Lannes E. Davis (U); Ion exchange reactions of clays, by D. R. Lewis (C); Adsorptive and swelling properties of clay-water system, by Isaac Barshad (U); Interlamellar sorption by clay minerals, by Douglas M. C. MacEwan (U); PART III—Particle size distribution in clays, by A. L. Johnson (C); Interpretation of chemical analyses of clays, by W. P. Kelley (U); Interpretation of chemical analyses of montmorillonites, by Bernard B. Osthaus (C); Petrographic study of clay materials, by Ralph E. Grim (U); Dye adsorption as a method of identifying clays, by Charles G. Dodd (C); Infrared analysis of clays and related minerals, by Paul G. Nahin (C); Identification of clay minerals by x-ray diffraction analysis, by George W. Brindley (U); Electron microscopy as a method of identifying clays, by Thomas F. Bates (U); Differential thermal analysis of clays, by Richards A. Rowland (C); PART IV—Role of the physical properties of clays in soil science, by J. B. Page (U); Role of the chemical properties of clays in soil science, by T. F. Buehrer (U); PART V—Importance of clay in applied soil mechanics, by Francis N. Hveem (Calif. Div. Highways); Physical-chemical properties and engineering performance of clays, by Richard C. Mielenz (Bur. Reclamation) and Myrle E. King (Bur. Reclamation); PART VI—Clay technology in ceramics, by Edward C. Henry (U); PART VII—Use of clay in drilling fluids, by Delmar H. Larsen (C); Role of clay in well-log interpretation, by M. R. J. Wyllie (C); Role of clay in oil reservoirs, by Norris Johnston (C); Use of clays as petroleum cracking catalysts, by T. H. Milliken (C), A. G. Oblad (C), and G. A. Mills (C)
170. Geology of southern California. CHAPT. III: Correlation of sedimentary formations in southern California, by Gordon B. Oakeshott (SDM), Charles W. Jennings (SDM), and Mort D. Turner (SDM); Rocks of Paleozoic age in southern California, by Charles W. Merriam (GS); Mesozoic formations and faunas, southern California and northern Baja California, by W. P. Popenoe (U); The marine Cenozoic of southern California, by J. Wyatt Durham (U); Fossil Foraminifera of the Los Angeles and Ventura regions, California, by M. L. Natland (C) and W. T. Rothwell (C); Cenozoic land life of southern California, by Donald E. Savage (U) and Theodore Downs (Los Angeles Mus.), with illustrations by Owen J. Poe (U); Marine-nonmarine relationships in the Cenozoic section of California, by J. Wyatt Durham (U), Richard H. Jahns (U) and Donald E. Savage (U); Tertiary basins of southern California, by William H. Corey (C); CHAPT. VI: Hydrology of the Los Angeles region, by Harold C. Troxell (GS) and Walter Hofmann (GS); Hydrology of the Mojave Desert, by Harold C. Troxell (GS) and Walter Hofmann (GS); Geology and hydrology of Ventura County, by R. G. Thomas (Div. Water Res.), E. C. Marliave (Div. Water Res.), L. B. James (Div. Water Res.), and R. T. Bean (Div. Water Res.); CHAPT VII: Minerals in southern California, by Joseph Murdoch (U) and Robert W. Webb (U); Problems of the metamorphic and igneous rocks of the Mojave Desert, by Thane H. McCulloh (U);

The batholith of southern California, by Esper S. Larsen, Jr. (U-GS) ; Miocene volcanism in coastal southern California, by John S. Shelton (U) ; Pegmatites of southern California, by Richard H. Jahns (U) ; Contact metamorphism in southern California, by Ian Campbell (U) ; Contact metamorphism at Crestmore, California, by C. Wayne Burnham (U) ; Anorthosite complex of the western San Gabriel Mountains, southern California, by Donald V. Higgs (U) ; CHAPT. VIII: Salines in southern California, by William E. Ver Planck (SDM) ; Saline deposits of southern California, by Russell W. Mumford (C) ; The Mountain Pass rare-earth deposits, by Jerry C. Olson (GS) and Lloyd C. Pray (U) ; Tungsten in southeastern California, by Paul C. Bateman (GS) and William P. Irwin (GS) ; Base metal and iron deposits of southern California, by Donald Carlisle (U), Dudley L. Davis (C), Malcolm B. Kildale (C), and Richard M. Stewart (SDM) ; Gold and silver mining districts in the Mojave Desert region of southern California, by Dion L. Gardner (C) ; Occurrence and use of nonmetallic commodities in southern California, by Lauren A. Wright (SDM), Charles W. Chesterman (SDM), and L. A. Norman Jr. (SDM) ; CHAPT. IX: History of oil exploration and discovery in California, by Harold W. Hoots (C) and Ted L. Bear (C) ; Origin, migration, and trapping of oil in southern California, by Frank S. Parker (C) ; Oil and gas production in California, by Frank B. Carter (C) ; Stratigraphic traps for oil and gas in the San Joaquin Valley, by Harold W. Hoots (C), Ted L. Bear (C), and William D. Kleinpell (C) ; CHAPT. X: Earthquakes and earthquake damage in southern California, by Charles F. Richter (U) ; Residential building-site problems in Los Angeles, California, by John T. McGill (U) ; Subsidence of the Wilmington oil field, California, by U. S. Grant (U) ; GEOLOGIC GUIDE NO. 2, Ventura Basin, by Charles W. Jennings (SDM) and Bennie W. Troxel (SDM)

Special Reports

38. Geology of the Silver Lake talc deposits, San Bernardino County, California, by Lauren A. Wright (SDM)
40. Geology of the Calaveritas quadrangle, Calaveras County, California, by Lorin D. Clark (GS)
41. Geology of the Angels Camp and Sonora quadrangles, Calaveras and Tuolumne Counties, California, by John H. Eric (GS), Arvid A. Stromquist (GS), and C. Melvin Swinney (GS)
42. Geology of mineral deposits in the Ubehebe Peak quadrangle, Inyo County, California, by James F. McAllister (GS)

Reprints

Journal, vol. 49, no. 3: Flotative properties of titanium minerals in oleate solutions, by V. P. Pradhan (U) and D. W. Mitchell (U)

Journal, vol. 49, no. 4: Mines and mineral resources of Mendocino County, Califorfornia, by J. C. O'Brien (SDM) ; Index to volume 49 (SDM)

Journal, vol. 50, no. 1: Mines and mineral resources of Amador County, by Denton W. Carlson (SDM) and William B. Clark (SDM) ; Annual report of the State Mineralogist . . . for the 104th fiscal year . . . , by Olaf P. Jenkins (SDM) ; California mineral commodities in 1951, by Henry H. Symons (SDM) and Fenelon F. Davis (SDM)

POPULAR REPORTS

The editorial section of the Division of Mines completed the third in a series of papers on the history of mineral discovery and development in California, which was published as a supplement to the October 1953 *California Journal of Mines and Geology* under the title *De Argento Vivo, Historic Documents on Quicksilver and Its Recovery in California Prior to 1860*. Two other papers of the series are being prepared—one on the use of rhyolite tuff as a building stone in the Mother Lode, the other on the history of hydraulic mining in California; the former is well under way, the latter still in the planning stage. Both have been temporarily discontinued during the assembling of the multiple-

authorship Bulletin 170, *Geology of Southern California*, a cooperative project between The Geological Society of America and the California State Division of Mines.

STATE GEOLOGIC MAP

Three years have passed since the stock of the 1938 state geologic map, scale 1:500,000, was sold out. Constant demand for this invaluable regional map makes it imperative that the Division of Mines issue a new state map.

A new project is under way to prepare coverage of the general geology of California on the scale of 1:250,000. This new map is to be issued in thirty sheets, and will form an atlas. In area, each sheet covers two degrees east-west by one degree north-south.

Eight sheets of the new map have now been prepared and copy is being made for printing as a preliminary issue without color. Ten other

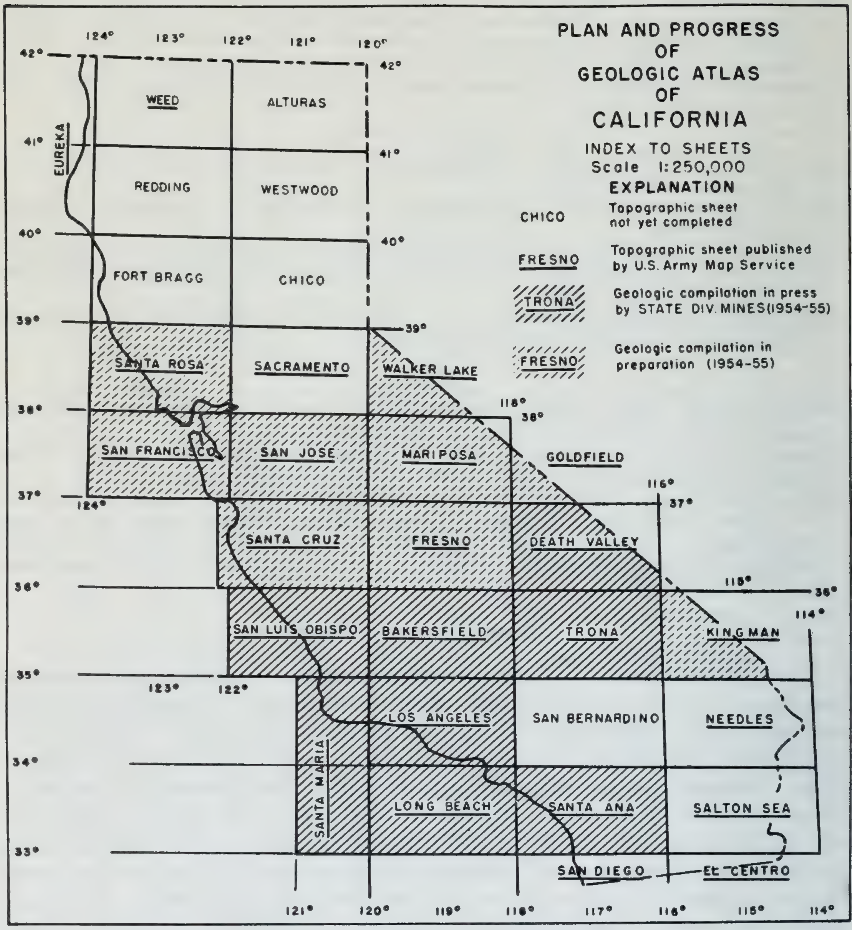

FIGURE 12. Index map of California showing plan and progress of geologic atlas sheets.

sheets are now well under way. It is planned that when all are complete the map will be issued in color and that these sheets will match both in scale and color. The entire undertaking has attracted much interest and has received wholesome cooperation from hundreds of contributors. It should be considered a continuing project, and a place where all new data may be assembled in a coordinated and usable form. The compilation is being carried on by Charles J. Kundert under the direct supervision of Olaf P. Jenkins, who compiled the 1938 Geologic Map of California.

BASIC GEOLOGIC MAPPING

The Division of Mines' long-range program of basic geologic mapping of the state (largely on quadrangle areas) was continued during the fiscal year 1953-54. Four new geologic reports with detailed geologic maps were released—Breckenridge Mountain, Ferndale-Fortuna, Lower Lake, and Ortigalita Peak quadrangles. Five more of this series of colored lithographed quadrangles were in press at the close of the fiscal year, and 82 additional quadrangles were in preparation. The previously published geologic maps of this series continued to be in great demand by petroleum and mining companies carrying on exploration programs, as well as by engineers, agriculturists, and the scientifically interested public.

The geologic mapping of quadrangles is done in large part by research geologists (professors or graduate students) affiliated with universities. In some cases the mapping is done by private research geologists or geologists who may be affiliated with geological departments of exploration companies. Detailed mapping of the geology and mineral deposits of quadrangles is also being done by the U. S. Geological Survey through a cooperative program; only those quadrangles which the State may publish are listed below.

Staff geologists of the Division of Mines have undertaken geologic mapping of certain quadrangles of particular economic importance. Projects actively under way by the Division include the Barstow 30-minute quadrangle (completed and in press) by Oliver E. Bowen, Jr.; San Fernando 15-minute quadrangle (field mapping and laboratory work completed, report in preparation) by Gordon B. Oakeshott; Matterhorn Peak 15-minute quadrangle (field mapping completed, report in preparation) by Charles W. Chesterman; Shoshone and Tecopa 15-minute quadrangles (field mapping in progress) by Lauren A. Wright.

Within the boundaries of the Barstow quadrangle are numerous nonmetallic and metallic mineral deposits such as limestone, dolomite, ganister, clay, mica, pyrophyllite, silver, lead, gold, iron, and copper. These are the source of a major part of the mineral wealth currently coming from San Bernardino County. Cement is the leading mineral commodity.

San Fernando quadrangle lies in the western San Gabriel Mountains and marginal areas in Los Angeles County. The area is particularly valuable for a number of mineral commodities of current and potential value, including petroleum, limestone and dolomite, graphite, titanium ore, rock, sand and gravel, and volcanic ash. The old Elsmere

Canyon, Whitney Canyon, and Schist oil fields and the active Placerita oil field are in the western part of the quadrangle.

Matterhorn Peak quadrangle lies in the high Sierra Nevada northwest of Mono Lake. In addition to its great scenic attraction, the area is noted for its gold mines and potentialities for tungsten.

Shoshone-Tecopa quadrangles cover a mountainous desert area, for the most part in Inyo County, southeast of Death Valley. Lead, zinc, silver, gold, talc, saline minerals, pumice, and perlite are among the major economic minerals found in this area.

The following list shows progress of the basic geologic mapping program to July 1, 1954. The quadrangles listed are 15-minute (scale: 1:62,500), unless otherwise indicated. The letter preceding the name of the quadrangle indicates the affiliation of the geologists who are doing the work:

D—Division of Mines
U—University geologist
S—Federal Geological Survey (cooperative program)
O—Other professional geologist

The symbol (example, H 15) following the quadrangle name serves as a means of locating it on the index map.

Recently published geologic map and report:

(U) Antioch (K 16)
(U) Blue Lake (C 5)
(O) Breckenridge Mt. (X 27)
(U) Carquinez (J 16)
(S) Cuyamaca Peak (F′ 37)
(U) Ferndale (A 6)
(U) Fortuna (B 6)
(O) Gaviota (R 31)
(U) Healdsburg (G 14)
(U) Jamesburg (L 23)
(U) Lebec, 7½-min. (W 29)
(O) Lompoc (Q 30)
(O) Los Olivos (R 30)
(U) Lower Lake (H 13)
(U) Macdoel, 30-min. (I 1, I 2, J 1, J 2)
(U) Mare Island (I 16)
(U) Mount Vaca (J 15)
(S) Neenach (X 29)
(U) Ortigalita Peak (O 21)
(U) Petaluma (H 16)
(O) Point Arguello (P 30)
(O) Point Conception (Q 31)
(U) Point Reyes (G 16)
(U) Quien Sabe (N 21)
(O) Saltdale (A′ 27)
(U) San Benito (N 22)
(U) San Jose (E½)—Mt. Hamilton (W½) (KL 19)
(U) San Juan Bautista (L 21)
(U) Santa Rosa (H 15)
(U) Sebastopol (G 15)
(U) Sonoma (I 15)
(U) Tesla (L 18)
(U) Vacaville (K 15)

Geologic map published, report in preparation:

(U) Copperopolis (P 17)
(U) Hollister (M 21)
(O) Lake Elsinore (C′ 34)

Geologic map and report in press:

(S) Angels Camp 7½-min. (P 16)
(D) Barstow, 30-min. (C′ 29, C′ 30, D′ 29, D′ 30)
(S) Calaveritas 7½ min. (P 16)
(S) Sonora 7½ min. (Q 17)
(S) Ubehebe Peak (B′ 22)

Geologic map and report nearly ready for press:

(U) Big Bend S. W. (K 4)
(S) Big Pine (Y 20)
(S) Bishop (Y 19)
(U) Colfax S. ½ (O 12)
(U) Dardanelles Cone (S 15)
(U) Desert Creek Peak (U 14)
(O) Hernandez Valley (O 23)
(S) Mt. Goddard (X 20)
(S) Mt. Tom (X 19)
(D) San Fernando (Y 31)
(S) Santa Catalina Island (X 35, Y 35)
(U) Santa Ysabel (F′ 36)
(U) Sonora Pass (T 15)
(U) West Mono Lake (U 16, 17)
(U) Wheeler Peak (U 15)

Geologic map completed, report in preparation:

(S) Casa Diablo Mt. (X 18)
(U) Ebbett Pass (S 14)
(O) Fremont Peak (C′ 28)
(D) Matterhorn Peak (U 16)
(S) New Almaden (K 20)
(S) New York Butte (A′ 22)
(O) Opal Mt. (D′ 28)
(U) Oroville (L 10)
(U) St. Helena (I 14)
(S) San Andreas (P 16)
(U) Sutter Creek (O 15)
(U) Topaz Lake (T 14)

In preparation; field work completed or nearly completed:

(U) Adelaida (O 26)
(U) Bradley (O 25)
(U) Bryson (N 25)
(U) Capay (J 14)
(U) Cape San Martin (M 25)
(U) Carbona (M 18)
(U) Cholame, 30-min. (Q 25, Q 26, R 25, R 26)
(U) Cuyapaipe (G′ 37)
(O) Imperial Valley quadrangles
  Agua Dulce (H′ 35)
  Barrel Spring (H′ 36)
  Brawley (J′ 37)
  Carrizo Mt. (H′ 37)
  Coyote Wells (H′ 38)
  Durmid (I′ 35)
  Heber (J′ 38)
  Kane Spring (I′ 36)
  Plaster City (I′ 37)
(U) King City (N 24)
(D) Masonic Mt. (V 15)
(U) Nipomo (Q 28)
(U) Orestimba (N 19)
(U) Paso Robles (P 26)

In preparation:

(O) Auburn (N 13)
(U) Banning (E′ 33)
(D) Bodie (V 16)
(U) Blairsden (P 9)
(U) Branch Mt. (R 28)
(U) China Mt. (H 3)
(S) Darwin (B′ 23)
(S) Devils Post Pile (V 18)
(O) Emigrant Canyon (D′ 23)
(U) Greenville (O 8)
(U) Indian Gulch (R 19)
(U) Joaquin Rocks (Q 23)
(U) Kettle Rock (P 8)
(U) La Panza (R 27)
(U) Ladoga (I 11)
(U) Lucerne Valley (E′ 31)
(U) Merced Falls (Q 18)
(S) Mono Craters (V 17)
(U) Mt. Boardman (M 19)
(S) Mt. Morgan (W 18)
(U) Mt. Stanford (W 19)
(O) New Idria (P 23)
(U) Palo Alto (J 19)
(U) Perris (D′ 33)
(U) Priest Valley (O 23, 24, P 23, 24)
(U) Reiff (I 13)
(U) Rumsey (J 13)
(U) Shadow Mts. (B′ 30)
(D) Shoshone (G′ 25)
(D) Tecopa (H′ 25)
(U) Triunfo Pass (W 32)
(U) Valley Springs (O 16)
(U) Wilbur Springs (I 12)

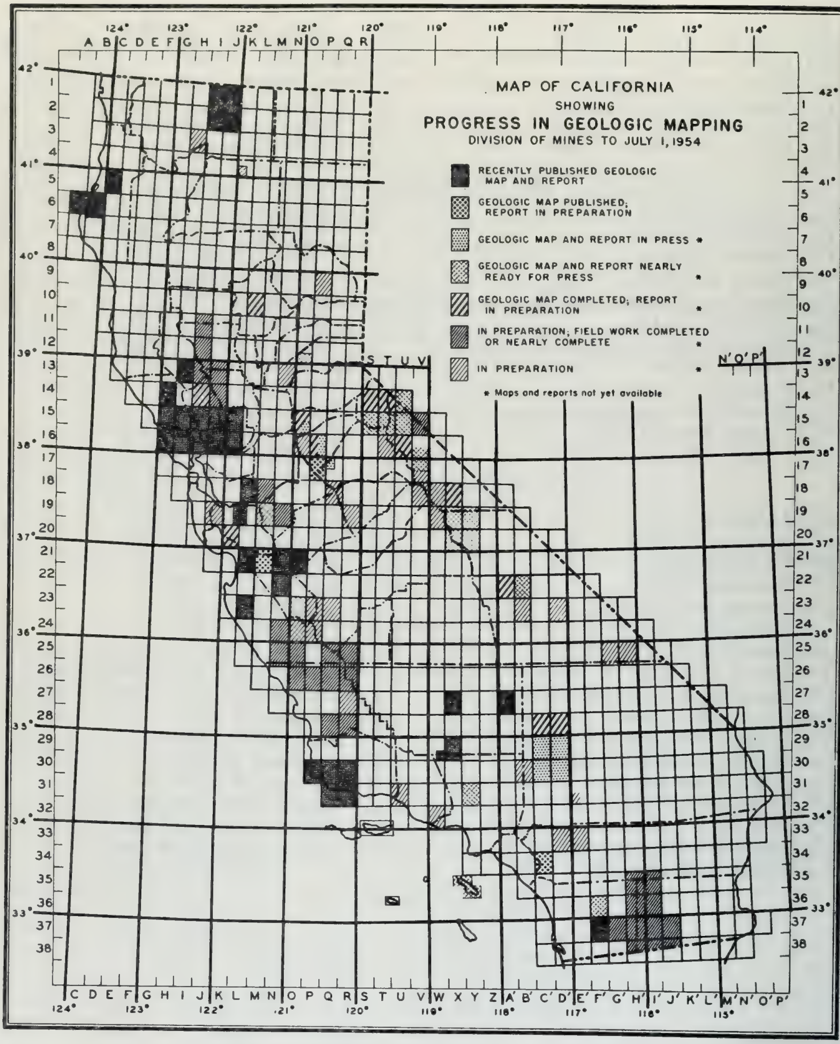

FIGURE 13. Index map of California showing progress in quadrangle geologic mapping.

KLAMATH MOUNTAINS SURVEY

During the fiscal year the Division of Mines continued its survey of the geology and mineral resources of the Klamath Mountains, begun in the summer of 1952. This vast area is one of the most highly mineralized in California, yet one in which the geology is still virtually unknown. Basic geological mapping is necessary to point up the mineral potential of the Klamath Mountains, and it was with this in mind that the program was initiated. During the past year emphasis was placed on a study of the mineral resources. Particular consideration was given to a study of potential deposits of strategic minerals, especially asbestos and nickel, occurring in the large bodies of ultramafic rocks in this

area. A program of reconnaissance geologic mapping of this area was undertaken by the U. S. Geological Survey. In this work the Division of Mines collaborated.

INVESTIGATION OF EARTHQUAKES

On July 21, 1952, the towns of Arvin and Tehachapi, in Kern County, in the southern part of the San Joaquin Valley and southern Sierra Nevada, respectively, were severely damaged by one of the strongest of the many earthquakes California has experienced. On August 22 a second major earthquake damaged Bakersfield. The Division of Mines began an immediate investigation of the earthquakes and completed a program of geologic mapping of rock formations and structure in the area which had begun some time before the first shock. At the request of several agencies the Division enlisted the cooperation of a large number of geologists, seismologists, and structural engineers to coordinate their studies with the objective of publishing a comprehensive account of the series of earthquakes in bulletin form.

As a result, three major aspects of the earthquakes are covered in 34 papers by some 36 authors, each a specialist in his field, in the Division's Bulletin 171. Part I of the bulletin comprises maps and papers discussing the principal geological features and particularly the White Wolf fault zone in relation to geologic structure of the area; Part II deals with the seismology of the area and 1952 earthquakes and includes a detailed analysis of the records obtained by seismographs; Part III summarizes the damage to buildings, railroad, and other engineering structures. Scientific papers contributed have come principally from geologists, seismologists, and engineers of the following agencies which cooperated: American Society of Civil Engineers, California Institute of Technology, California Division of Highways, California Division of Water Resources, Intex Oil Company, Pacific Fire Rating Bureau, Pacific Gas and Electric Company, Richfield Oil Corporation, Southern Pacific Railroad, Stanford University, Union Oil Company, University of California (Santa Barbara), U. S. Coast and Geodetic Survey, U. S. Geological Survey (Engineering Branch, Groundwater Branch, Mineral Deposits Branch) and Western Gulf Oil Company.

Bulletin 171, Symposium on Kern County, California, Earthquakes of 1952, compiled and edited by Gordon B. Oakeshott, was completed and undergoing final preparation for printing on July 1, 1954. In September 1952 the Division published preliminary accounts of the earthquakes in *Mineral Information Service.* Staff members have given over 20 illustrated talks, have distributed a number of fault maps, and answered numerous oral inquiries on the earthquakes. In cooperation with the Pacific Fire Rating Bureau, the Division geologist in charge of the earthquake investigation prepared a paper on *Geologic setting and effects of the Kern County earthquakes* which was published as a contribution to *An engineering study of the southern California earthquake of July 21, 1952, and its aftershocks,* Bulletin Seismological Society of America, April 1954 (Second Part).

MINERAL UTILIZATION SURVEY

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

The mineral wealth of California may be measured in terms of mineral utilization and markets. Therefore, the importance of the Division of Mines' mineral utilization surveys can hardly be overemphasized. Information on uses of minerals and the marketing of them assist all segments of the mineral industry—owners of mineral deposits, producers, processors and consumers.

Specific utilization surveys made by Division of Mines personnel, and other data secured by staff members in the course of mineral commodity investigations, together with contributions by technical members of the industry, and published and unpublished data, are all channeled into the Division of Mines' Information Service files for daily use. Later, this information will be processed and made available through publication. In many instances, utilization surveys have resulted in establishing Division of Mines' work projects, since the surveys often show particularly important and critical needs for certain data on raw materials.

The needs for mineral materials by industry, as well as the specifications for such materials are incorporated in many of the reports that appear in Division of Mines' publications. In the Division's forthcoming bulletin on mineral commodities of the state, this aspect of mineral uses will be emphasized wherever possible.

SURVEY OF MINING ACTIVITIES

Public Resources Code:

"2208. The State Mineralogist or a qualified assistant may at any time enter or examine any and all mines, quarries, wells, mills, reduction works, refining works, and other mineral properties or working plants in this State in order to gather data to comply with the provisions of this chapter."

The two criteria most commonly used to measure the value of the state's mineral industry are (1) the figures showing mineral production, and (2) the activities of mining as indicated by mineral exploration, development, exploitation and beneficiation of the state's mineral resources. For this reason, surveys of mining activities constitute an important part of the Division of Mines' work. Such surveys are conducted specifically for maintaining an inventory of mines and their current operations. Other data pertaining to those activities are also secured during other types of field investigations. All the information thus obtained is made currently available for ready reference and can be processed and assembled at any time for publication.

Reports on mining activities by counties or by districts appear in issues of the quarterly California Journal of Mines and Geology. Short reviews and news items concerning mining activities are published in *Mineral Information Service*. More detailed data are included in *Special Reports* and *Bulletins*.

Reports on the mines and mineral resources of Amador, Kings, Mendocino, and Santa Clara counties appeared in the *California Journal of Mines and Geology* during the 1953-54 fiscal year. Manuscripts were submitted covering Los Angeles, Sacramento and San Joaquin counties. Field work was under way in Calaveras, Imperial, El Dorado, Mariposa, Marin, Monterey, San Francisco, San Mateo, San Diego, Shasta, Tulare, and Trinity Counties.

Another current field program concerns the recent gold mining activities in the Alleghany district, Sierra County.

Mineral Information Service during the 1953-54 fiscal year contained a variety of articles on mining activities. These included a review of recent manganese mining in California, glass sand operations, activities in the salt industry operations, and a review of the Defense Minerals Exploration Administration program in California.

ORE BUYERS' LICENSES AND INSPECTION

Public Resources Code:

"2250. It is unlawful for any person to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing, or receiving for sale, ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets, or specimens without first procuring the license provided for by this chapter."

"2253. The application for a license to carry on such business shall be made to the State Mineralogist. . . ."

"2267. Every licensee under this chapter shall file monthly with the State Mineralogist a report of all purchases made under this chapter. The reports shall be made upon forms prescribed by the State Mineralogist and shall contain the information required by this chapter."

Sixty-three ore buyers' licenses were issued by the Division of Mines, 36 of which were limited licenses (limits the buyer to $1,000 in purchases during the calendar year) and 27 of which were unlimited licenses (no limit on purchases).

Reports of suspected illegal gold transactions and gold thefts were investigated during the year in close cooperation with local, state and federal agencies. Licensees' records were inspected and transactions checked.

LOS ANGELES BRANCH OFFICE

The general activities of the Division of Mines, as noted in this annual report, include many contributions from the Los Angeles branch office, which maintains a technical personnel of six mining geologists with Lauren A. Wright in charge.

The following report on office activities shows significant increase in the Division's services. Increasing population of the Los Angeles area, expansion of industrial development and investments, and acceleration of the technical program of the Division are all factors which have caused increases in demands by the public.

Office Information Services

Fiscal years	*1952-53*	*1953-54*	*Percent change*
Total pieces of outgoing correspondence	3599	3526	—2
Total number of telephone calls	7739	7929	+2
Visitors	5630	7540	+33
Mineral Information Service subscribers	2143	2333	+8
*Publication sales: Total pieces	5386	7001	+30
Total value	$4928	$7433	+51

* Exclusive of sales at professional meetings in Los Angeles area handled by San Francisco staff members.

Several hundred square feet of office space was added to the Division's crowded quarters in the State Building. This now gives the Division twelve rooms or areas in which to operate. As a result, the working conditions are materially improved, and there is more room for housing its selected technical library, map files and displays, and new mineral cabinet, all of which are available to the public. Even so, the offices are very limited and crowded for the work and services performed.

Southern California contains one of the largest mineral market areas in the United States. No area in the world has more variety of industrial mineral deposits, both producing and potential. For these reasons, the future outlook for the mineral industry is indeed favorable. Not only are there a large number of persons and agencies in the area who constantly demand information, but many technical persons, institutions, and organizations in Los Angeles contribute to the knowledge of geology, mineral resources, and markets of mineral rock products. For these reasons, the Los Angeles office finds itself particularly active and centered in the study of all phases of mineral commodities, mineral utilization and in the detailed study of the geology and mineralization of southern California. The study of mineral commodities and utilization is, however, by nature of statewide scope, and therefore there is necessity of frequent exchange of information between this office and headquarters in San Francisco. Personnel from the two offices are required to travel extensively throughout the whole state to acquaint themselves with the problems which confront the industry as a whole.

Progress was made by the Los Angeles personnel in the following field assignments:

1) Inventory reports on mineral resources of Los Angeles County (completed), San Diego and Imperial Counties (under way), Kern County (started, but suspended on account of lack of personnel).

2) Statewide detailed commodity reports on sand and gravel, wollastonite, tungsten, and talc (Silver Lake talc report completed).

3) Contributions to a general report to form a comprehensive bulletin on all mineral commodities of the state.

4) Contributions to the Division's current survey on mineral utilization.

5) Contributions to the Division's forthcoming Bulletin 170, "Geology of Southern California," prepared in cooperation with the Geological Society of America. These contributions include geologic road logs and guides for the Ventura Basin, Los Angeles Basin, Mojave-Death Valley area, and Peninsular Range. It includes also reports on occurrence and use of nonmetallic minerals in southern California, and geologic reports on Shadow Mountains, Alexander Hills, and Talc City.

6) Preparation of economic mineral reports to accompany geologic maps on the Elsinore, Breckenridge, Cross Mountain, and Santa Ysabel quadrangles.

7) General reports for *Mineral Information Service* on clay in Los Angeles County, glass sand in California, and on the minerals used in the welding rod industry.

8) A study was started on the behavior of shales when heated in furnaces. The purpose of this project is to assist in the development of the expanded shale industry, which uses the product as a lightweight concrete aggregate.

SACRAMENTO BRANCH OFFICE

The Division's Sacramento office comprises two adjoining rooms in State Office Building No. 1. Close proximity to headquarters in San Francisco affords the personnel opportunity of serving and frequently making use of facilities (laboratory, mineral exhibits, and library) of the main office. Two resident geologists, Denton W. Carlson (in charge) and William B. Clark, work in and out of the Sacramento office with their field of activity largely in the Sierra Nevada and in the market area about Sacramento. The office reports increases in activity over the previous fiscal year of about 48 percent.

Office Information Services

Fiscal years	*1952-53*	*1953-54*	*Percent increase*
Total pieces of outgoing correspondence	1042	1976	89
Total number of telephone calls	591	803	36
Visitors	1086	1269	17
Mineral Information Service subscribers	143	213	49
Publication sales: Total pieces	935	986	5
Total value	$805	$1207	50

The growth in population and the expansion of industrial development of the Sacramento area accounts in large measure for the increase in demand upon the Division's services. Many letters of inquiry were received from California residents concerning placer mining for gold. Letters from sources outside the state often request information on various mineral commodities and frequently ask for samples of mineral and rock specimens from California. These reflect the interest of potential investors.

Manuscripts were prepared for publication on the mineral resources of Sacramento and San Joaquin Counties and on the mineral commodity, mica, for *Mineral Information Service*. Also, general reports on gold and platinum were prepared. Field investigations were carried on in Calaveras and El Dorado Counties and in the gold district of Alleghany in northern Sierra Nevada. Effort was made particularly to keep abreast with current gold mining activities in the Mother Lode country, including particularly Placer, Nevada, and Sierra Counties. The personnel of the Sacramento office frequently is called upon to make public talks and appearances and to serve at the State Fair where the Division maintains a display and model mine.

REDDING BRANCH OFFICE

The Redding office of the Division of Mines maintains two rooms in the State Division of Forestry building. The office maintains one technical employee, J. C. O'Brien, who reported the following office activities.

Office Information Services

Fiscal years	*1952-53*	*1953-54*
Total pieces of outgoing correspondence	379	973
Total number of telephone calls	715	444
Visitors	985	1098
Mineral Information Service subscribers	312	331
Publication sales: Total pieces	293	282
Total value	$145	$290

Revision of chapters on copper and zinc for the Division's new bulletin on mineral commodities of California was completed. It included a description of the flotation process for sulfide ores and the methods of smelting concentrates. A list of commercial forms and products and the composition, physical characteristics, and uses of various alloys and compounds were added to both chapters.

Reports describing the mines and mineral deposits of Shasta and Trinity Counties were started, and card indexes were made listing the mines and prospects in both counties. Some current mining activities were checked in Del Norte, Humboldt, Shasta, Siskiyou, Tehama, and Trinity Counties during the year.

REPORT OF THE U.S. GEOLOGICAL SURVEY ON COOPERATIVE STUDIES OF MINERAL DEPOSITS IN CALIFORNIA[1]

(Fiscal Year 1954)

By Edgar H. Bailey[2]

Geologic investigations of mineralized areas of California by the U. S. Geological Survey, under a cooperative agreement with the California State Division of Mines, continued during the fiscal year beginning July 1, 1953, but on a slightly smaller scale than during the preceding year. However, the gross amount of geologic work being carried on in California under non-cooperative programs of the Survey continued at essentially the same level as in Fiscal Year 1952-53. A major event directly affecting the cooperative work was the construction and occupancy of the Survey's new building in Menlo Park.

The total cost of the cooperative work amounted to approximately $80,000 and, as during the several preceding years, the State contributed the previously agreed upon sum of $35,000. The Survey's contribution of $45,000 represents a decrease from the preceding year, and, because of the large amount of non-cooperative Survey work in the State, no new cooperative projects were undertaken during the year. At the beginning of Fiscal Year 1954 the cooperative program includes the following seven projects: East Shasta copper-zinc, Ubehebe Peak lead-zinc, Darwin lead-zinc, Bishop tungsten, Eastern Sierra tungsten, Sierra Foothills mineral belt, and the Office. All of these, except Ubehebe Peak, had budget allotments during Fiscal Year 1954, but owing

[1] Publication authorized by the Director, U. S. Geological Survey.
[2] Geologist, U. S. Geological Survey, Menlo Park.

to the completion of manuscripts and the transferring of personnel, the only projects that are being carried into Fiscal 1955 are Darwin lead-zinc, Bishop tungsten, Eastern Sierra tungsten, Sierra Foothills mineral belt, and the Office.

East Shasta Copper-Zinc

The geologic study of the important and geologically complex Shasta copper-zinc district was divided into two parts; the investigation of the western part was completed in fiscal 1952, and that of the eastern part was completed during fiscal year 1954. A comprehensive report titled, ''Geology and ore deposits of the East Shasta copper-zinc district, Shasta County, California,'' planned for publication by the Survey, is now in late stages of preparation. To make the information contained in the detailed areal geologic map of the district quickly available, it was placed in open file at the San Francisco office of the California Division of Mines. A by-product report on the Bully Hill-Rising Star mine area is partly prepared, but its completion has been delayed to incorporate data from the deep levels of the Bully Hill mine, which are being reopened under a Defense Minerals Exploration Administration.

Ubehebe Lead-Zinc

No funds were allotted for the Ubehebe Peak project in fiscal 1954, and the former project chief has been reassigned to non-cooperative project in California. Nonetheless, he was able to make final field checks and complete data on the mineral deposits for publication by the Division of Mines, and a geologic quadrangle map series report for publication by the Survey. One of the two chief objectives of the work, to map and describe the mines and mineral deposits of the quadrangle, is met by a report submitted to the State Division of Mines. The other main objective of the study, to establish a stratigraphic sequence that can be carried into adjacent mineralized areas, was also achieved, as a complete stratigraphic sequence, extending from Middle Cambrian to Permian was measured and described in detail, including descriptions of fossils.

Darwin Lead-Zinc

The geologic mapping of the Darwin quadrangle, an area of notable mineral wealth where little geologic work has been done in the past, was completed during the first half of the year. During the winter office season quadrangle and mine maps were compiled, cross sections leading to an analysis of the structural control of the ore bodies were constructed and reports were partly prepared. An economic report, to be published by the Division of Mines, and a bulletin planned for publication by the Survey, are now in advance stages of preparation. In addition, a short description of the Defense mine (lead-silver), which is in the Argus Range immediately adjacent to the project area, was written and is being processed for publication. The geologists returned to the field in the fiscal year to complete a large-scale geologic map of the Darwin mine area and to start mapping on the adjacent Panamint Butte quadrangle.

Bishop Tungsten

The Bishop Tungsten district, in northern Inyo County, is one of the most productive tungsten districts in the United States, and accounts in a large measure for California being ranked, during the last several years, as the leading tungsten producing state. Essentially all of the field work for the systematic study of the mines and geology of four 15-minute quadrangles was completed in 1950.

Considerable progress has been made in preparing the two final reports. The first of these, ''The economic geology of the Bishop district,'' which is directed primarily to the miner and prospector and emphasizes features that have direct bearing on the discovery and exploitation of mineral deposits, was completed, reviewed, and revised during the year. It contains 55 illustrations, most of which are maps, and is to be published by the State Division of Mines. A comprehensive report, less restricted in scope and with emphasis on the scientific rather than the economic aspects of the area, is now well underway and is planned for publication by the Survey.

During the year, the Geophysics Branch of the Survey conducted a gravity survey in the Bishop tungsten district. The purpose of this survey is to provide data bearing on the configuration of the bed rock surface beneath the alluvial fill in Owens and Round Valleys. Knowledge of the shape of the bed rock surface in these areas is significant from the practical standpoint of water supply, and in addition, it provides information bearing on the structural development of the region.

Eastern Sierra Tungsten

The area being studied under this project includes five 15-minute quadrangles adjacent to the Bishop tungsten district. In this area are both actively and potentially commercial deposits of tungsten as well as of gold, silver, copper, and lead. The mapping is being done on a quadrangle basis, with reports prepared on each quadrangle as the mapping is completed. Fiscal 1954 was devoted chiefly to completion of the mapping and preparation of reports on the first of these quadrangles, the Casa Diablo Mountain quadrangle. A report on the economic geology, to be published by the Division of Mines, is now in late stages of preparation, and a comprehensive report on the quadrangle planned for publication by the Survey is in preparation. The economic geology report includes a quadrangle map designed for use in prospecting, and detailed maps of the mines and prospects, including the currently very productive Black Rock tungsten mine.

Mapping of the second quadrangle (the Mt. Morgan quadrangle) also is well under way. The mapping to date has revealed an unbroken, fossiliferous stratigraphic section more than 20,000 feet thick that includes rocks ranging in age from Ordovician to Carboniferous. Further mapping is expected to reveal even younger rocks, possibly Triassic or Jurassic in age. This section may become classic for east-central California.

Sierra Foothills Mineral Belt

This project is the successor of the Mother Lode project. The Mother Lode project involved detailed mapping of the Mother Lode belt, quadrangle by quadrangle, and provided refinement of the series of U. S.

Geological Survey folios on the gold belt that were prepared prior to the turn of the century, but it resulted in only slow progress toward an understanding of the regional stratigraphic and structural relationships. These relationships are major factors in the localization of the valuable mineral commodities that have been mined: gold, silver, copper, zinc, and limestone. The aim of the present project is to achieve more rapidly and at less cost an understanding of the stratigraphic and structural relationships of the Sierra Foothills belt as a whole. By establishing these relationships existing geologic maps can be modified to yield much new information at a fraction of the cost of new large-scale mapping. The maps that have been prepared of the Sierra Foothills mineral belt reveal alternating linear bands of sedimentary and volcanic rocks that extend parallel to the Sierra Nevada front, but only locally have the structural relationships of the rocks been clearly established. As the best exposures of the rocks are along the major river valleys, which cut across the linear rock units, the field work for the Sierra Foothills project has evolved into detailed studies of the geology along the river valleys. By the end of Fiscal 1954, the valleys of the Stanislaus, Merced, Tuolumne, Calaveras, Mokelumne and Cosumnes Rivers had been studied. From the data gained in this study, and by drawing upon earlier work done by the Survey, the project chief is preparing (1) a revised geologic map of the region embraced by the six river valleys, (2) structure sections along the six river valleys, (3) stratigraphic columns, and (4) a report explaining the interrelations of the rock units.

Office Activities

At the end of the Fiscal Year, in addition to the district supervisor and his assistant, the office staff consisted of two draftsmen, a chief clerk, an accounting clerk, and three clerk-typists. The responsibilities of the office staff include programming and planning of projects, acting as liaison between State and Federal agencies, co-ordinating work with the over-all Survey programs, answering inquiries from the general public, maintaining files of geologic and topographic maps and aerial photos of California, submitting monthly and annual reports on Cooperative work, preparing and drafting of illustrations, typing and processing of manuscripts, and taking care of correspondence, accounting, supplies, and other requirements for the geological staff. During the fiscal year, 25 manuscripts pertaining to California geology were handled by the California District Office; of these, 12 manuscripts containing 1,440 pages and 230 illustrations, chiefly maps, resulted directly or indirectly from the cooperative program. During the year 11 manuscripts totalling 760 pages and 160 illustrations were transmitted to the State Division of Mines for publication.

Other Contributions to California Geology

As a contribution to the *Guidebook to Southern California,* to be published by the State Division of Mines in conjunction with the Geological Society of America's annual meeting to be held in Los Angeles, the geologic staff prepared a "Geologic map of the Owens Valley region," and a report and illustrations on "Tungsten in southeastern California," in addition we were in a position to aid in completion of the

''Ventura basin section,'' the ''Geologic map of the San Andreas fault zone from Soledad Pass to Cajon Pass,'' and to review and transmit the report on the ''Mountain Pass rare-earth deposits.''

The Survey continued work on a number of projects in California that do not fall under the cooperative program but which, nonetheless, have made valuable contributions to the study of the geology and mineral deposits of the State. The principal non-cooperative programs being carried on are: mine appraisals for the Defense Minerals Exploration Administration, continuing studies of quicksilver deposits, reconnaissance for radioactive materials, a systematic study of the saline deposits of the Mojave desert area, and reconnaissance mapping of the northern Coast Ranges and western Klamath mountains.

The Survey's New Building

In December of 1953 the offices for some of the geologic activities of the Geological Survey were moved from the Old Mint Building in San Francisco to new quarters at 4 Homewood Place in Menlo Park. Although a considerable part of the 40,000 square feet in the new building was devoted to special facilities used by the research staff, it also provides offices for personnel engaged in administrative activities such as personnel actions, purchasing, and many supporting ''housekeeping'' activities. The efficiencies we are now realizing by having consolidated these functions will no doubt become even more apparent as other units now operating out of various field offices in the western states are brought together at the Menlo Park office.

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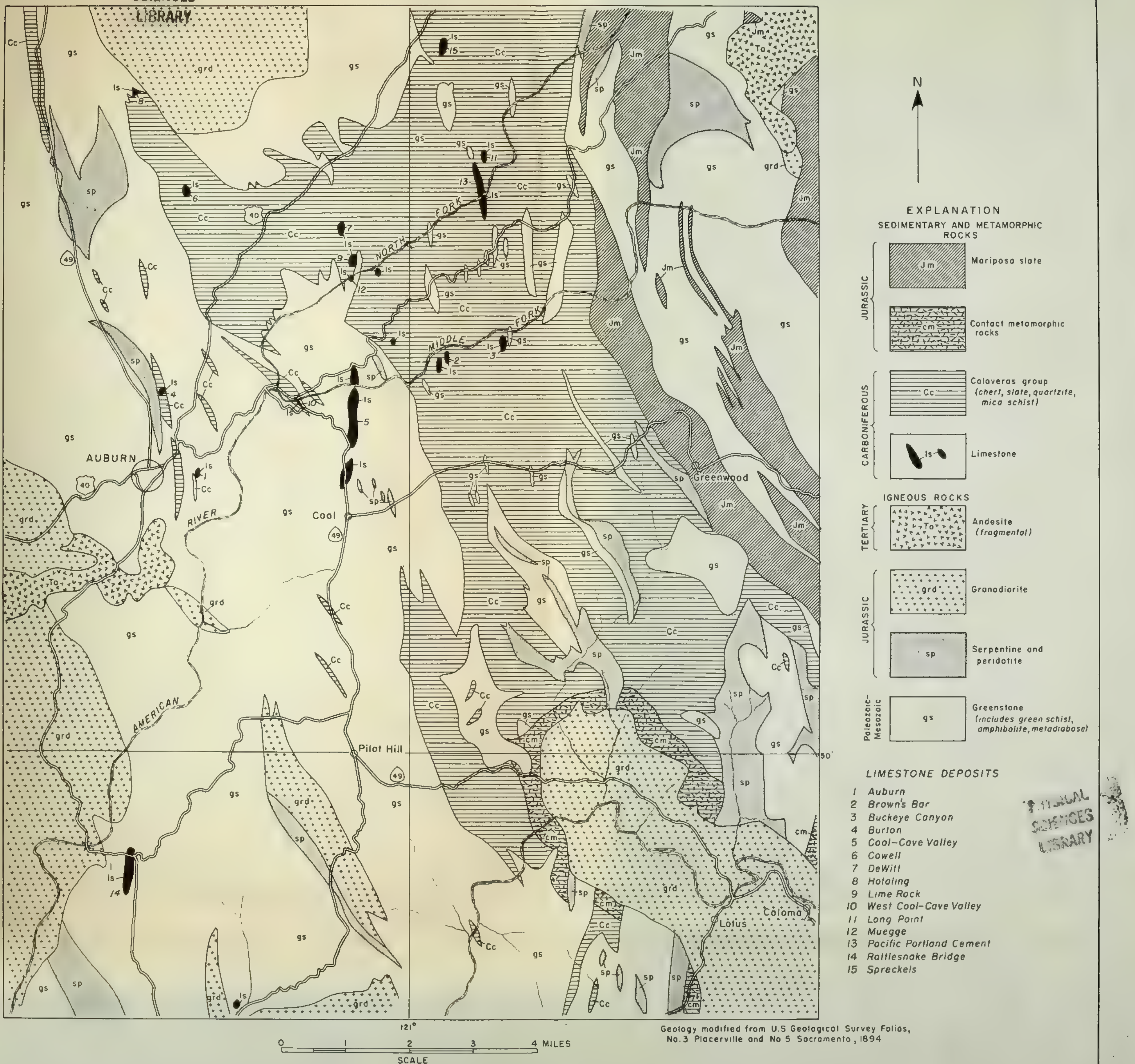
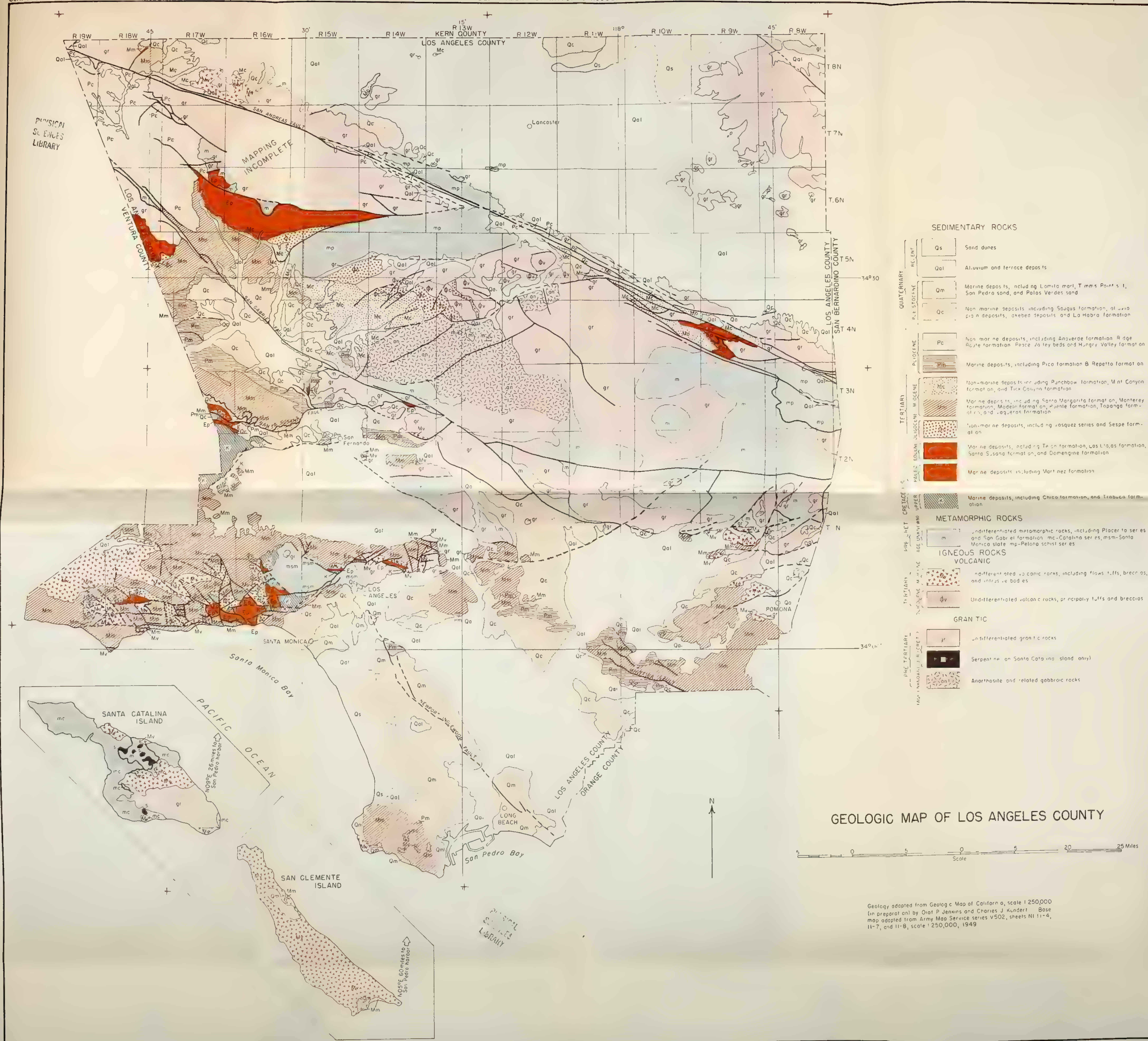


GEOLOGIC MAP OF THE COOL—CAVE VALLEY AREA
SHOWING LOCATION OF LIMESTONE DEPOSITS


GEOLOGIC MAP OF LOS ANGELES COUNTY
KERN COUNTY
LOS ANGELES COUNTY
VENTURA COUNTY
SAN BERNARDINO COUNTY
ORANGE COUNTY
MAPPING INCOMPLETE
SAN ANDREAS FAULT
SAN GABRIEL FAULT
NEWPORT-INGLEWOOD FAULT
Lancaster
San Fernando
LOS ANGELES
SANTA MONICA
POMONA
LONG BEACH
Santa Monica Bay
San Pedro Bay
PACIFIC OCEAN
SANTA CATALINA ISLAND
N50°E 26 miles to San Pedro harbor
SAN CLEMENTE ISLAND
N50°E 60 miles to San Pedro harbor
SEDIMENTARY ROCKS
QUATERNARY
RECENT
Qs Sand dunes
Qal Alluvium and terrace deposits
PLEISTOCENE
Qm Marine deposits, including Lomita marl, Timms Point silt, San Pedro sand, and Palos Verdes sand
Qc Non-marine deposits including Saugus formation, alluvial plain deposits, lakebed deposits and La Habra formation
TERTIARY
PLIOCENE
Pc Non-marine deposits, including Anaverde formation, Ridge Route formation, Peace Valley beds and Hungry Valley formation
Pm Marine deposits, including Pico formation & Repetto formation
MIOCENE
Mc Non-marine deposits including Punchbow formation, Mint Canyon formation, and Tick Canyon formation
Mm Marine deposits, including Santa Margarita formation, Monterey formation, Modelo formation, Puente formation, Topanga formation, and Vaqueros formation
OLIGOCENE
Non-marine deposits, including Vasquez series and Sespe formation
EOCENE
Marine deposits, including Tejon formation, Los Llajas formation, Santa Susana formation, and Domengine formation
PALEOCENE
Marine deposits including Martinez formation
CRETACEOUS
UPPER
K Marine deposits, including Chico formation, and Trabuco formation
METAMORPHIC ROCKS
PRE-CRETACEOUS
AGE UNKNOWN
m Undifferentiated metamorphic rocks, including Placerita series and San Gabriel formation. mc-Catalina series, msm-Santa Monica slate, mp-Pelona schist series
IGNEOUS ROCKS
VOLCANIC
TERTIARY
MIOCENE
Mv Undifferentiated volcanic rocks, including flows, tuffs, breccias, and intrusive bodies
OLIGOCENE
Φv Undifferentiated volcanic rocks, principally tuffs and breccias
GRANITIC
PRE-TERTIARY
gr Undifferentiated granitic rocks
Serpentine (on Santa Catalina Island only)
an Anorthosite and related gabbroic rocks
Scale
25 Miles
Geology adapted from Geologic Map of California, scale 1:250,000 (in preparation) by Olaf P Jenkins and Charles J Kundert. Base map adapted from Army Map Service series V502, sheets NI 11-4, 11-7, and 11-8, scale 1:250,000, 1949

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

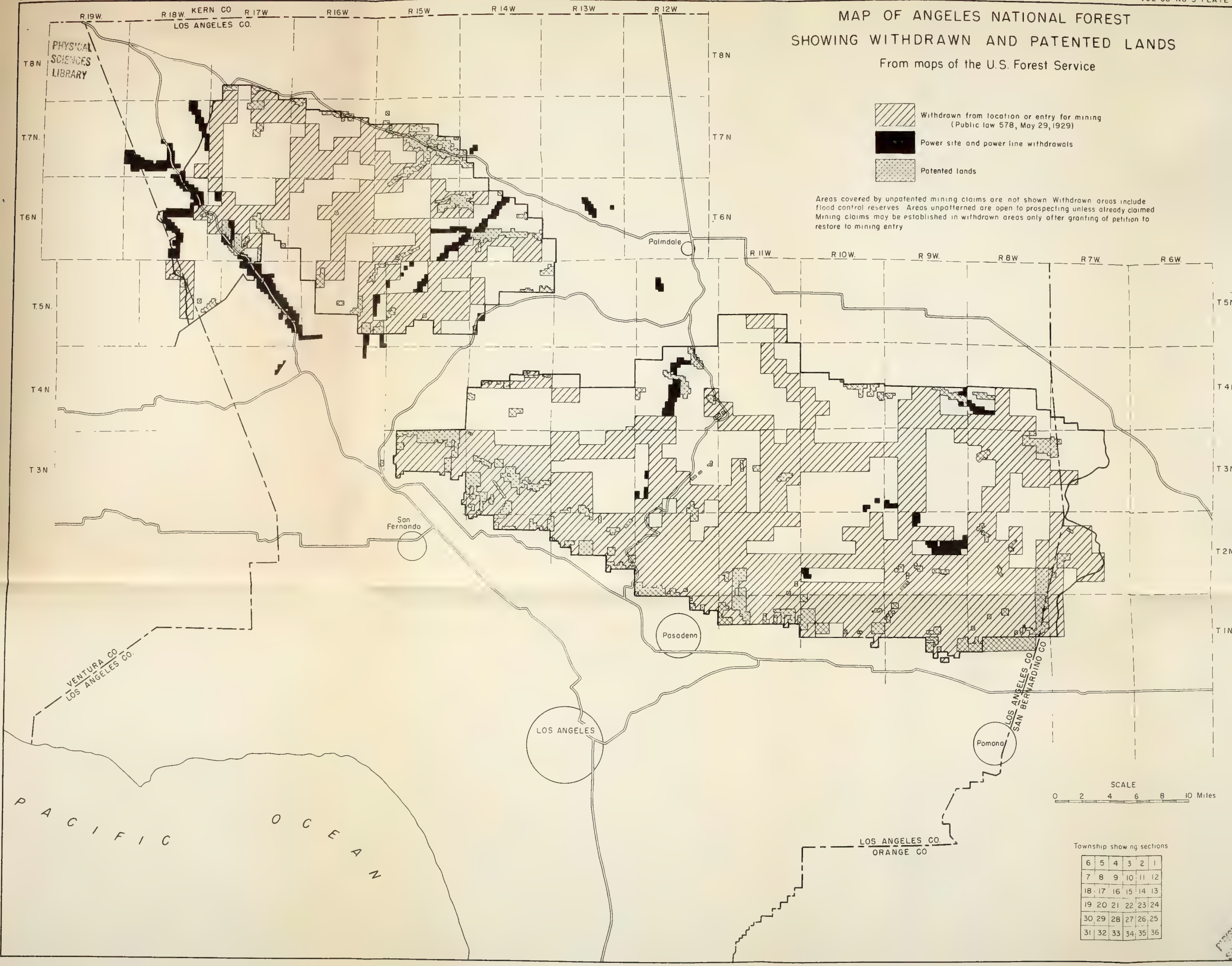
STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

Journal 3 & 4 Volume 50
Plates E & F Combined

MAP OF
LOS ANGELES COUNTY
CALIFORNIA
THE DEPARTMENT OF FORESTER AND FIREWARDEN
COUNTY OF LOS ANGELES
SPENCE D TURNER – FORESTER AND FIREWARDEN
PRINTED 1935
0 1 2 3 4 5 MILES
INTELLIGENCE DIV
LEGEND
MAIN HIGHWAYS – FEDERAL – STATE – COUNTY
FIRST CLASS ROADS
SECOND CLASS ROADS
U S FOREST SERVICE FIRE TRUCK TRAILS
L A CO FIRE WARDEN FIRE TRUCK TRAILS
U S FOREST SERVICE FIREBREAKS
L A CO FIRE WARDEN FIREBREAKS
U S FOREST SERVICE TRAILS
L A CO FIRE WARDEN TRAILS
U S FOREST SERVICE COMMUNICATION SYSTEM
L A CO FIRE WARDEN COMMUNICATION SYSTEM
COUNTY BOUNDARY LINE
BOUNDARY LINE OF INCORPORATED CITIES
BOUNDARY LINE OF LAND GRANTS
BOUNDARY LINE OF NATIONAL FORESTS
TOWNSHIP AND RANGE LINES
SECTION LINES
STEAM RAILROADS
ELECTRIC RAILROADS
TRANSMISSION LINES
U S G S TRIANGULATION STATIONS
CORNERS OF U S G S QUADRANGLE SHEETS
SMALL TOWNS
OIL TANKS AND RESERVOIRS
U S FOREST SERVICE GUARD STATIONS
U S FOREST SERVICE RANGER STATIONS
L A COUNTY FIRE WARDEN STATIONS
L A COUNTY FIRE WARDEN BATT HEADQUARTERS
U S FOREST SERVICE LOOKOUT STATIONS
L A CO FIRE WARDEN LOOKOUT STATIONS
U S FOREST SERVICE WATER SUPPLY TANK
L A CO FIRE WARDEN WATER SUPPLY TANK
LOOKOUT TOWER ORIENTATION POINT
RESERVOIRS AND LAKES
DRAINAGES
COUNTY FIRE DEPT ENGINE COMPANIES
U S FOREST SERVICE PUBLIC CAMP GROUNDS
Explanation of symbols, numbers refer to list
(1) Copper
(2-59) Gold
(60-64) Lead-Silver-Zinc
(65-66) Manganese
(67-103) Titanium
(104) Asbestos
(105) Borates
Clay products
Diatomaceous earth
Feldspar
Graphite
Gypsum
Limestone and dolomite
Mica
Broken and crushed stone
Decomposed granite
Sand and gravel
Specialty sands
Salt
Silica
Oil field boundaries
MINES AND MINERAL PRODUCT LOCATIONS
CALIFORNIA STATE DIVISION OF MINES
Oil field producing zones adapted from maps by Division of Oil and Gas, AAPG
N
S
R 20 W
R 19 W
R 18 W
R 17 W
R 16 W
R 15 W
R 14 W
R 13 W
R 12 W
R 11 W
R 10 W
R 9 W
R 8 W
R 7 W
T 2 N
T 1 N
T 1 S
T 2 S
T 3 S
T 4 S
T 5 S
SAN FERNANDO
BURBANK
GLENDALE
PASADENA
ALTADENA
SIERRA MADRE
MONROVIA
ARCADIA
AZUSA
GLENDORA
CLAREMONT
LA VERNE
POMONA
COVINA
WEST COVINA
SOUTH PASADENA
SAN MARINO
SAN GABRIEL
ALHAMBRA
MONTEREY PARK
MONTEBELLO
HOLLYWOOD
BEVERLY HILLS
WESTWOOD
LOS ANGELES
SANTA MONICA
VENICE
INGLEWOOD
VERNON
HUNTINGTON PARK
MAYWOOD
BELL
SOUTH GATE
LYNWOOD
COMPTON
WHITTIER
EL SEGUNDO
HAWTHORNE
GARDENA
MANHATTAN BEACH
HERMOSA BEACH
REDONDO BEACH
TORRANCE
WILMINGTON
SAN PEDRO
LONG BEACH
SIGNAL HILL
SEAL BEACH
PALOS VERDES ESTATES
HOLLYWOOD LOOKOUT
SAN CLEMENTE ISLAND
SANTA CATALINA ISLAND
CATALINA PAT STA

MAP OF ANGELES NATIONAL FOREST SHOWING WITHDRAWN AND PATENTED LANDS

From maps of the U.S. Forest Service



EXPLANATORY MAP TO ACCOMPANY SHADED RELIEF MAP, LOS ANGELES AREA OF CALIFORNIA

SCALE 1:500,000

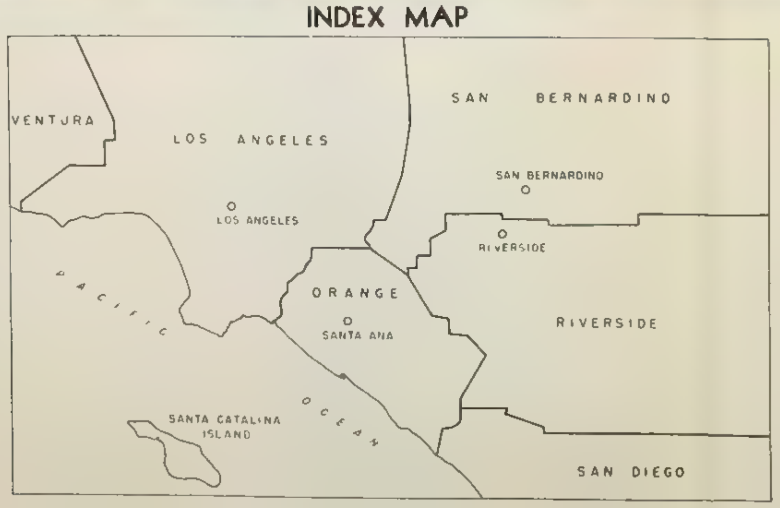
4 0 4 8 12 16 20 Miles

Indicating names of surface features and major faults that have topographic expression visible on the shaded relief map.

DIVISION OF MINES
OLAF P. JENKINS, CHIEF

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

INDEX MAP



LOS ANGELES AREA OF CALIFORNIA

Accompanying California Journal of Mines and Geology, July 1954